THE STATUS OF THE ATLANTIC SALMON STOCK OF HUMBER RIVER/BAY OF ISLANDS, NEWFOUNDLAND, 1993

by

C.C. Mullins and G. Chaput
Department of Fisheries and Oceans
Science Branch
P.O. Box 2009
Corner Brook, Newfoundland
A2H 6Z6

ABSTRACT

The total recreational catch of retained small salmon on the Humber River in 1993 was similar to the catch in 1992 but 14% below the 1987-1991 mean. The recreational catch of released large salmon, however, was 29% below the catch in 1992 but 77% above the 1987-1991 mean. The results of a creel survey conducted on the Big Falls segment of the Humber River from June 9 to August 20 indicated that the total 1993 recreational catch of retained small salmon was approximately 50% greater than reported in traditional DFO catch statistics. The catch of small salmon estimated from the creel survey was 1,677 compared to 882 from DFO catch statistics. The estimated total returns of small salmon to the Humber River in 1993, based on the derived angling exploitation rate, were similar to those in 1992. However, estimated large salmon returns were 78% below those in 1992. The estimated potential egg deposition to the Humber River in 1993 was 27.1 million eggs, approximately 89% (95% C.I. 53% to 137%) of target requirement. Lower egg depositions in 1993 relative to 1992 are attributed to lower large salmon abundance.

RÉSUMÉ

Le nombre total de petits saumons de la rivière Humber capturés et gardés en 1993 était comparable à celui de 1992, mais inférieur de 14 % à la moyenne de 1987-1991. Toutefois, les prises sportives de grands saumons remises à l'eau étaient inférieures de 29 % à celles de 1992, mais supérieures de 77 % à la moyenne de 1987-1991. Les résultats d'une enquête effectuée entre le 9 juin et le 20 août auprès des pêcheurs qui pratiquent leur activité dans la partie de la rivière Humber située à Big Falls révélaient que les prises sportives totales de petits saumons gardées étaient supérieures de 50 % environ aux prises déclarées dans les statistiques traditionnelles du MPO. En ce qui concerne les petits saumons, les prises estimées d'après l'enquête se chiffraient à 1 677, comparativement à 882 d'après les statistiques de prises du MPO. Les montaisons totales de petits saumons dans la rivière Humber en 1993, estimées d'après le taux d'exploitation des pêcheurs sportifs, étaient comparables à celles de 1992. Toutefois, les montaisons de grands saumons étaient inférieures de 78 % à celles de 1992. La ponte estimée dans la rivière Humber en 1993 était de 27,1 millions d'oeufs, soit environ 89 % (I.C. 95 % - 53% à 137 %) de la cible. La diminution de la ponte par rapport à 1992 est attribuée à une moindre abondance des grands saumons.

INTRODUCTION

This is the 4th assessment of the Humber River/ Bay of Islands area Atlantic salmon resource. This area is one of four river systems within the Gulf of St. Lawrence selected for a pilot study of the River/Zone Management Strategy. The Humber River flows into the Bay of Island coastal area which is situated in western Newfoundland at the northern limit of Salmon Fishing Area (SFA) 13 (Figure 1). Atlantic salmon were exploited commercially in this coastal area until 1991 but this fishery was closed in 1992 to help rebuild declining stocks. Low stock levels in the Bay of Islands have been indicated by egg depositions which were below target requirements on the Humber River in 1990 and 1991 (Chaput and Mullins 1991, 1992). Recreational fisheries in 1992 continued to harvest salmon in 3 of the 4 tributaries within the bay but were limited by the quota on small salmon harvests which was implemented in SFA 13. Egg depositions estimated for the Humber River stock in 1991 were well below the target spawning requirements for the Humber River system (Chaput and Mullins, 1992) which is the largest tributary of the Bay of Islands. With the commercial fishery closed in 1992 estimated egg depositions were above the target spawning requirement for the first time in seventeen years.

The total drainage area of the tributaries flowing into the Bay of Islands is 8124 km^2, which is 93% of the drainage area of Statistical Area L (Table 1) and 57% of SFA 13 drainage area. The Humber River comprises 95% of the Bay of Islands drainage area and flows into Humber Arm (Figure 1) at latitude 48° 57'N and longitude 57° 53' W. The total length of all the streams in the Humber River is 2450.5 km. Complete obstructions to migrations of anadromous Atlantic salmon within the Humber River system occur at Main Falls (Figure 2) which is 112.6 kilometres from the river mouth and at Junction Brook which was diverted for hydroelectric development in 1925. The diversion of Junction Brook which flowed into the Humber River at Deer Lake, resulted in the loss to the Humber River system of the anadromous salmon production potential of the Grand Lake system (Porter et al. 1974) (see Figure 2).

Several Atlantic salmon resource conservation measures have been imposed on the commercial and recreational fisheries since 1978 which have impacted on harvests within the Humber River / Bay of Islands area. The major conservation measures have included:

1) 1978 - commercial fishing season shortened to June 1-July 10 from May 15-December 31
2) 1984 - mandatory release of large salmon ($\geq$63 cm fork length) introduced in the recreational fishery
3) 1987 - seasonal bag limit of 15 small salmon (<63 cm fork length) introduced in the recreational fishery
4) 1990 - 35 metric ton quota imposed in the SFA 13 commercial fishery
5) 1991 - 25 metric ton quota imposed in the SFA 13 commercial fishery
6) 1991 - seasonal bag limit of 10 small salmon in the recreational fishery
7) 1992 - five year moratorium on the commercial salmon fishery
8) 1992 - quota of 5,000 small salmon introduced in SFA 13 recreational fishery and a quota of 100 small salmon for the Adies Lake segment of the Humber River (Figure 2); a catch and released fishery was permitted after the quota was reached.
9) 1992 - seasonal bag limit of 8 small salmon in the recreational fishery
10) 1993 - quota of 5,200 small salmon in SFA 13 (4,160 for June 5-July 31 and 1,040 for Aug.1 Sept.6); daily bag limit of one fish. Cook's Brook was closed for the season.

The assessment of the status of the Humber River/Bay of Islands Atlantic salmon stock is based on the analysis of annual trends in the catches from the recreational fishery and the estimation of spawning escapement. Spawning escapement is estimated using derived exploitation rates in the recreational fishery applied to total recreational fishery harvests. The present document provides the catches, effort, and timing data for the recreational fisheries of Humber River / Bay of Islands for 1993. It follows the initial assessments presented for 1990, 1991 and 1992 (Chaput and Mullins, 1991; Chaput and Mullins, 1992; Mullins and Chaput, 1993) and

addresses the following topics:

1) verification by independent creel method, of the recreational catch statistics collected by the Department of Fisheries and Oceans (DFO) for the Big Falls segment of the Humber River;
2) estimation of the exploitation rate by the recreational fishery on small salmon in 1993 by mark-recapture methods;
3) updating of the biological characteristics of the Humber River/Bay of Islands Atlantic salmon stock for 1993;
4) examination of the effect of the 1993 management regulations on the spawning escapement to the Humber River.

MATERIALS AND METHODS

Recreational Fishery Statistics

The DFO catch statistics for the recreational fishery were compiled from river guardian and fisheries officer reports. The traditional methods used for summarizing these data are described in Mullins and Claytor (1989) and Mullins et al. (1989). Catch and effort for the Humber River are described by river segment (Figures 1 & 2) and the standardized weeks used are described in Table 2.

Salmon catches in the recreational fishery are categorized into small and large size groups. The criteria for small and large salmon designation are as follows:

Small (Grilse; 1SW) - < 63 cm fork length

Large (MSW) - ≥ 63 cm fork length

Weekly salmon angling reports are completed by DFO river guardians and fishery officers. Data recorded on a daily basis for each river or river segment include water level, observed and estimated rod-days of effort, and observed and estimated small salmon catch. One rod-day is the fishing effort expended by one angler during all or part of one day; two or more fishing periods by the same angler on the same day are counted as one rod-day. The observed data represent actual observations by the river guardians or fisheries officers and those reported to the individual by others (mostly through conversations with anglers). Estimated data represent effort and catches for days when the river or segment was not patrolled or while patrolling other areas. These estimates were based on the individual's knowledge of the migratory pattern of the salmon stock, local weather conditions, water levels, and patterns of local angling effort. Observed catches have generally accounted for 80% of the total catch reported (Mullins and Claytor 1989).

In 1992, weekly salmon angling reports were also completed for the catch and release fishery which was permitted after the SFA 13 zonal quota was reached.

Creel Survey, Big Falls

A creel survey to estimate the angling catch at Big Falls, Humber River, was conducted between June 9 and Aug. 20, 1993 which was about two weeks earlier than in previous years. The Big Falls segment (Figure 2) was again selected for the survey because it is accessed by anglers from two points and the angling catches from this segment have averaged 38% of the total Humber River catch since 1986. A "bus route" design (Robson and Jones 1989), in combination with lattice sampling (Robson 1990), was used to obtain catch and effort data of anglers at the two access points (Appendix 1).

The sampling day was divided into four time periods: 05:30 to 10:00, 10:00 to 14:00, 14:00 to 18:00, and 18:00 to 22:30. Two time periods were sampled every census day.

A stratum is a block of days treated as a unit. Weekly strata (7 days) were used at Big Falls in 1992. The number of time periods sampled within a stratum was dictated by the available resources and prior information on angling catch and effort timing at Big Falls. Sampling effort within strata consisted of 5 days per strata between June 8 and June 28, 7 days between June 29 and August 3, and 5 days between August 4 and August 30. The days and the time periods within the day to be sampled were randomly selected within each stratum. Among strata sorting followed when consecutive strata were equal in size (ex. 7 day or 5 day weekly strata).

The total catch for each stratum (week) was obtained by weighting the observed sampling period matrix with the Horvitz-Thompson matrix which gives equal weight to the individual sampling periods within a stratum (Robson 1990). The variance of the catch estimate was calculated for each stratum using the Yates-Grundy variance formulation (Robson 1990). Totals and variance estimate of totals for combined strata were obtained by summation. The confidence intervals of the estimate were calculated using $\pm$ 2 standard deviations.

Estimation of Exploitation Rate

Small and large salmon, captured in two traps operated in the estuary of the Humber River in 1993 (Figure 1), were marked with individually numbered blue Carlin tags and released. Tags were applied using a double stainless steel wire attachment, directly under the dorsal fin. All salmon, captured in the trapnets were measured (fork length 0.1 cm), and scale sampled.

Trap 1 (Lower Trap) - This trap, which has been fished at Wild Cove, Humber Arm, since 1990, was again fished in 1993 (Fig. 1). The trap design and installation were identical to the 1990-1992 sampling program (Chaput and Mullins 1991, 1992; Mullins and Chaput, 1993).

Trap 2 (Upper Trap) - This trap was fished for the first time in 1993 and was located about 2.4 km east of the lower trap. The upper trap was a floating design and was operated in 6 m water depth, farther into the estuary. The dimensions of the floating trap were 18.3 m length x 4.9 m width x 5.5 m depth and it was constructed of the same type 5.71 cm stretched mesh nylon as the lower trap.

The angling exploitation rate used to calculate returns of small salmon to the river in 1993 was the number of tags recaptured by anglers, divided by the number of tags available in the population. A summary of the equations used to calculate exploitation rate in 1993 are given in Table 3.

Estimation of Tags Recaptured

The proportion of tags recaptured by anglers that were returned voluntarily, could not be estimated for 1993. However, the proportion is assumed to be less than 1.0. The tag reporting rate estimated for the Humber River in 1990 was 0.698 (Chaput and Mullins, 1991) and 0.5 has been estimated for the Miramichi River, New Brunswick, which is a much larger river system than the Humber. Considering that DFO press releases were issued to inform anglers of the tagging program on the Humber River and that numerous opportunities existed on the river for anglers to return tags to guardians or the creel clerk, the voluntary reporting rate for the Humber River is assumed to be between 0.5 and 1.0. A value of 0.75 is used for convenience.

Tags Recaptured = Tags Returned by Anglers / Reporting Rate

Estimation of Tags Available

The total number of tagged small salmon available to anglers on the Humber River in 1993 was adjusted for the loss of tags from marked fish due to tag shedding. The adjustment for the tag loss rate was estimated based on the 'tag-loss' rate of 0.009 tags/day derived for Margaree River in 1992 (Chaput et al. 1994). The method of tag application to salmon in the Margaree River tagging program is the same as for the Humber River.

Tag-Loss Rate = 1-(0.009 tags/day x Median Days to Recapture)

Tags available to anglers was estimated from the number of tags applied to Humber River small salmon multiplied by the proportion of tags retained (TR).

$$\text{Tags Available} = \text{Tags Applied} \times TR$$

where:

$$TR = 1 - (\text{Tag-Loss Rate})$$

Estimation of Total Recreational Harvest

The total recreational harvest for the Humber River was estimated based on the creel survey estimate of small salmon catch at Big Falls and the proportion of the total harvest angled at Big Falls ie.:

Total Harvest = Catch at Big Falls (Creel) / Proportion at Big Falls

Two methods were used to estimate the proportion of the total river harvest angled at Big Falls were compared (Table 3). One based on the proportion of catch reported from Big falls in the DFO catch statistics and the other based on the proportion of tags returned from Big Falls.

Returns to the Humber River

The returns of small salmon to the Humber River were estimated by the Peterson Method (Single Cencus) (Ricker, 1975) based on the total recreational harvest of small salmon and the estimated angling exploitation rate.

Returns of Small = Total Harvest / ER
Returns of Large = Returns of Small x ratio of Large:Small in trapnets.

The returns of large salmon were determined by applying the ratio of large to small salmon captured in the two tagging trapnets to the estimate of small salmon returns. In the 1990 and 1991 assessments, the appropriate ratio of large to small salmon returns to the river was considered to be equivalent to the ratio of large to small salmon in the recreational fishery (7%) prior to 1984 when large salmon could be retained (Chaput and Mullins 1991, 1992). However, a commercial fishery was also permitted in these years. Because of the closure of the commercial fishery in 1992 and 1993 and the potential for an increase in the river escapement of large salmon, the ratio of large to small salmon captured at the Wild Cove trapnet was considered to be more representative of returns to the river.

Estimation of Confidence Levels

The confidence around the returns estimate was quantified using simulation techniques. The returns equation (Table 3) was solved a total of 5000 times with the following variables allowed to vary with each replication: tag loss rate; median days to recapture; reporting rate; proportion of large salmon; the creel survey estimated catch at Big Falls; the proportion of angling catch at Big Falls based on tag returns and the proportion of angling catch at Big falls based on DFO catch statistics. Variation in these variables was simulated using bootstrap techniques as described in Table 3.

Biological Characteristics

Biological characteristics of Humber River salmon in 1993 were obtained from bright salmon at the trapnets and from angling catches landed at the Big Falls segment of the Humber River. The fish were sampled for fork length (0.1 cm) and whole weight (0.01 kg) and sex determination was by internal examination except on live fish. Scale samples were obtained for determining the river-age and sea-age. These methods were identical to those used in 1990-1992.

Estimation of Target Spawning Requirements

Target egg deposition for the Humber River was calculated using an optimal egg deposition for fluvial and lacustrine parr rearing area. In previous assessments for the Humber lacustrine area had not been included in calculation the target egg deposition. The egg deposition rate used for fluvial area was 2.4 eggs/m^2 as described by Porter and Chadwick (1983) and the egg deposition rate used for lacustrine area was 368 eggs/ha as described by O'Connell et al. (1991). The fluvial parr rearing area for the Humber River has been estimated at 11,530,700 m^2 (Porter and Chadwick 1983). The available lacustrine area (Appendix 2) was measured from 1:50,000 scale topographic maps using a dot grid.

Estimation of Potential Egg Depositions

The potential egg depositions were calculated using the estimated spawning escapement and observed biological characteristics (mean weight of females, percent female, fecundity) of small and large salmon in 1993. The spawning escapement was obtained by subtracting the adjusted total recreational catch of small salmon retained from the estimated returns to the river. The total recreational catch for the river was adjusted upwards based on the angling exploitation rate for catches at Big Falls.

Returns to Counting Fences

The returns, by date, to counting fences on Hughes Brook and North Brook (see Fig. 1) for 1992 were collected by private development associations. Supervision and instruction in data compilation were provided by DFO, Science Branch staff. The Hughes Brook fence was operated between June 29 and September 21, 1993 and the North Brook fence was operated between August 7 and September 17, 1993. Returns to other counting facilities cited were enumerated by DFO, Science Branch staff.

RESULTS

Recreational Effort and Catches

The recreational angling season in the Bay of Islands opened on June 6 and closed on September 6, 1993. The total SFA 13 zonal quota of 5,200 small salmon and the Adies Lake quota of 100 small salmon were not reached.

The 1993 recreational catch of small salmon in the Bay of Islands region, from DFO catch statistics, was 7% above 1992 catches but 8% below the 1987-1991 mean and 20% below the 1953-1991 mean (Table 4). The proportion of the SFA 13 catch of small salmon taken in the Bay of Islands in 1993 was approximately 14% higher than in 1992 and similar to most years since 1984 (Table 4). The 1993 released catches of large salmon in the Bay of Islands, were 29% below 1992 catches but 78% above the 1987-1991 mean.

Within the Bay of Islands region, recreational catches from the Humber River remained the dominant proportion of the total catch (Table 5). The 1993 retained catch of small salmon on the Humber River was 2,206 fish, which was only slightly below the catch in 1992 and 14% below the 1987-1991 mean. The greatest contribution to the increased recreational catches in the Bay of Islands region in 1993 relative to 1992, was from Goose Arm River (Table 5). The 1993 catches of small salmon on Goose Arm River were the highest ever recorded on the river.

Released catches of small salmon from the Humber River in 1993, were 27% of retained catches (Table 6). This is more than three times the value in 1992 (8%).

The recreational catches on five of eight segments of the Humber River were above those in 1992 but only Little Falls and Taylors Brook segments had catches higher than the 1987-1991 mean (Table 7a). The Big Falls segment again produced the highest catches in 1993 but catches were 41% below those in 1992 and 7% below the 1987-1991 mean. The catch at Big Falls in 1992, the first year of the closure of the commercial salmon fishery in the Bay of Islands, was 200% above 1991 and 163% of the previous five year mean. The catch at Big Falls in 1993, represented 40% of the Humber River catch compared to 63% in 1992 and an average of 50% in 1976-1991. Harrimans Steady produced the largest proportion of the Humber River catch in 1993.

The released catch of large salmon at Big Falls was 63% below the catch in 1992 but 100% above the 1987-1991 mean and 14% below the (Table 7b).

The angling effort on the Humber River in 1993 was approximately 16% greater than in 1992, similar to the 1987-1991 mean and 10% below the 1977-1986 mean (Table 7c).

Creel Estimates for Big Falls

The creel survey estimate of retained small salmon at Big Falls for June 9 to August 20, 1993 was 1,676 fish (95% C.I. 1,470 - 1,882) (Table 8a). The estimated catch for the season, from DFO catch statistics, was 882 small salmon, which was below the 95% confidence limits of the creel estimate. The difference between the two estimates of small salmon catch at Big Falls was primarily in weeks 5-8, at the peak of the season, when creel catch estimates were much higher than the DFO catch statistics (Fig. 3a).

The distribution of weekly effort was similar between the two methods (Fig. 3b). Week 5 was the peak of angling effort in both the creel survey and DFO catch statistics estimates. Week 5 coincides with standardized weeks 26-27, which were the weeks of peak catches in 1986-1991 at Big Falls (Mullins et. al. 1989; Mullins and Claytor 1989; Mullins and Jones, 1994).

The 1,613 anglers interviewed in 1993 expended an average of 3.74 hours of effort compared to 2.20 hours in 1991 (Table 9). A higher proportion of anglers had also caught at least one fish in 1993, compared to anglers in 1991. The proportion of anglers with catch in 1993 was 0.32 compared to 0.24 in 1991 (Table 10).

Estimation of Exploitation Rate

The lower estuarial tagging trap was operated from June 2 to August 30 and the upper trap was operated from June 9 to August 31, 1993. A total of 22 bright large salmon and 668 small salmon were captured in the lower trap and 10 large salmon and 242 small salmon were captured in the upper trap. The ratio of the total large to small salmon captured in both traps was 0.035 (32/910), only 20% of the ratio in 1992 but similar to the ratio in 1991 (3/94).

The peak catches of small salmon in the lower trap occurred between early July and mid-July, but peak catches in the upper trap occurred between mid-June and early July (Fig. 4). The peak of large salmon catches occurred about June 21 in both traps. The last salmon was caught in the lower trap on Sept. 1 and the last catch in the upper trap was on July 29. The fork length frequency distribution of salmon was similar from both traps (Fig. 5).

A total of 830 (598 lower; 232 upper) small bright salmon were tagged and released from the two traps. Twelve of these were subsequently recaptured at the counting fence on Hughes Brook, and 119 were returned voluntarily by anglers.

The disribution of tag returns by week of recapture was similar to the distribution of angling catches (Table 11; Fig. 6), indicating that tagged fish were evenly dispersed in the population. Tagging was not carried out at surface water temperatures above 20° C and the number of tags returned did not appear to be related to the water temperature at the time of tagging (Table 12). Bottom temperature also did not exceed 20° C for the duration of the tagging program (Fig. 7).

None of the salmon tagged in the lower trap were recaptured in the upper trap.

Tags recaptures were recorded from all major segments of the Humber River (Table 13).

The largest number of tags were recaptured at Big Falls. The median number of days at large for tagged fish before recapture was 17 days (Table 14). The minimum was 0 days and the maximum was 80 days. The longest time at large before recapture was recorded for tags recaptured in the upper segments of the river. In 1993, the minimum angling exploitation rate, unadjusted for tag loss or tag reporting rate, was 0.1455 (119/818) which was similar to the unadjusted rates derived for 1990 (0.134) and 1991 (0.164). The maximum exploitation rate, after adjustment for tag loss and reporting rate, was 0.3319 on salmon tagged in the first two weeks of tagging. The overall 1993 exploitation rate, adjusted for tag loss and reporting rate, was 0.2213 (Table 14) which is similar to the adjusted rate of 0.25 derived for 1990 and applied to recreational catches in 1990-1991. The estimated tag retention rate (1 - tag loss rate) in 1993 of 0.86 (Table 14) was only 12% higher than the rate of 0.77 estimated in 1990 (Chaput and Mullins, 1991).

Biological Characteristics

The mean fork length of small, 1SW salmon sampled from the tagging trapnets in 1993 was 53.3 cm (N=885) compared to 55.6 cm (N=86) from the recreational fishery (Table 15). The mean weight of small, 1SW salmon in the trapnets was 1.44 kg (N=54) compared to 1.69 kg (N=69) in the recreational fishery. This difference suggests there may be some selection for larger fish in the recreational fishery. The sex composition of small salmon in the trapnets and the recreational fishery were similar (Table 15). The dominant smolt age of small, 1SW salmon was three years in the trapnets and the recreational fishery. However, the percentage at smolt age three years was higher fronm the trapnet samples. The mean fork length of large, MSW salmon sampled in the trapnets was 71.65 cm (N=28). Large salmon were not sampled from the recreational fishery.

Estimation of Spawner Requirements

Spawner requirements for the Humber River were updated based on biological characteristics recorded in 1992 and 1993 (Table 16). Spawner requirements to achieve sufficient females were estimated at 14,703 small and 1,428 large salmon. Spawner requirements for a 1:1 male to female spawning ratio were 22,332 small and 3,1320 large salmon.

Returns and Escapements to the Humber River.

The bootstrapped estimates and 95% confidence limits of the parameters used in calculation of 1993 returns to the Humber River are given in Table 17.

The two methods used to derive the total angling catch of small salmon on the Humber River produced similar estimates of total small salmon returns (Table 17). Estimated returns of small salmon in 1993 were 19,298 (95% C.I. 13,263 to 26,007) using the catch method and 19,113 (95% C.I. 12,573 to 27, 609) using the tags method. Corresponding returns of large salmon, based on the proportion of large salmon captured in the tagging traps, were 642 (95% C.I. 397 to 980) using the catch method and 636 (95% C.I. 379 to 1024) using the tags method of (Table 17). The 95% confidence intervals for small and large returns were narrower for those estimated by the catch method. The frequency distribution of bootstrapped estimates of small and large salmon returns based on explotation rate and the two methods used to derive the total angling catch are shown in Fig.s 8 and 9.

Using the more conservative of the two estimates of small and large salmon returns, spawning escapements in 1993 were estimated at 14,282 small and 636 large salmon (Table 17). Spawning escapements at this level would have resulted in potential egg depositions of 27.1 million or 89% (95% C.I. 53% to 137%) of the target egg deposition requirement (Table 18). This is 25% below egg depositions in 1992 but above most years prior to the commercial moratorium.

DISCUSSION

Recreational catch statistics indicated that the abundance of small and large salmon on the Humber River in 1993 were below 1992 levels. The interpretation of the recreational data is confounded by the unknown effect of the change in the daily bag limit to one fish per day from two fish per day in 1992. However, the conclusion of lower abundance in the Humber River in 1993 is supported by the fact that the SFA 13 quota was reached in 1992 but not in 1993. The higher angling effort on the river in 1993, compared to 1992 and the 1987-1991 mean was probably the result of the one fish per day bag limit which required anglers to make more fishing trips in 1993 to catch fewer fish.

The results of the creel survey conducted at Big Falls in 1993, also indicated that small and large catches were below 1992 levels. However, the estimated catches from the creel survey were approximately twice as high as the catches estimated from DFO catch statistics. This was the second consecutive year that the creel survey indicated significantly higher catches at Big Falls than those reported by the DFO catch statistics. In contrast to 1992 and 1993, there was no discrepency between the two methods in 1991, when the total catch on the river was the second lowest in more than thirty years. It appears that when angling activity increased in 1992 and 1993, it became more difficult to obtain accurate catch data by the traditional methods.

Based on the creel survey results, the total recreational catch of small salmon on the Humber River in 1993 may have been as much as two times higher than the estimate provided by DFO catch statistics. According to the proportion of tagged salmon recaptured at Big Falls, 40% of the catch of small salmon on the Humber River in 1993 were taken on this segment of the river. Adjustment of the creel survey estimate at Big Falls to the whole river resulted in a total recreational catch of small salmon in 1993 which was only 4% below the total catch estimated in 1992 using the same method. The catch of small salmon on the Humber River in 1992 and 1993 were the highest since 1975 and coincided with the implementation of the five year commercial moratorium introduced in 1992.

The use of two tagging traps in 1993, to estimate the angling exploitation rate, resulted in a 39% increase in the number of salmon tagged and released. However, none of the fish tagged in the lower trap were recaptured in the upper trap. This might have been because the upper trap was too close to the lower trap. Salmon tagged in the lower trap might not have had sufficient time to recover from the tagging procedure to be trapped a second time. The proportion of tags recaptured by angling was similar for both traps, indicating that the location of tagging did not affect the availability of tags in the river. The distribution of tagged and untagged fish in the recreational fishery appeared to be similar, indicating that the run-timing of both groups was similar.

The minimum angling exploitation rate in 1993, unadjusted for tag loss or reporting rate, was 0.1455. This value is similar to the unadjusted rate in 1990 (0.134) and 1991 (0.164). The 1993 unadjusted value is not directly comparable to 1992 because only tag returns actually observed by the creel survey clerk at Big falls were used in the calculation of the exploitation rate. Adjustments to account for tag loss and reporting rate in 1990, resulted in a maximum exploitation rate of 0.25 (Chaput and Mullins, 1991) which was also used to estimated returns in 1991. This was similar to the 1993 adjusted value of 0.22. Any differences might be accounted for by annual variation in the tag loss and reporting rates.

Estimated returns of small salmon to the Humber River in 1993 were about 5% above returns in 1992, corresponding to higher spawning escapement in 1988 compared to 1987 (Table 19). The returns of large salmon in 1993 were 78% below those in 1992, the first year of the commercial moratorium. The significantly lower large salmon returns in 1993 relative to 1992, however, do not correspond to the lower returns of large salmon in 1987 relative to 1986. The decrease in egg depositions relative to 1992 can be attributed to the lower large salmon abundance in 1993.

Partial counts obtained at the counting fences on Hughes Brook and North Brook (Table 20) also indicated lower abundance of large salmon in the Bay of Islands in 1993 compared to 1992.

Atlantic salmon on the Humber River spend an average of three years in the river before migrating to sea (Table 15). In 1993, approximately 80% of returning adult salmon had a river-age of three years and 97% had spent one year at sea before returning to spawn for the first time. Based on the average time spent in the river and at sea, the majority of returns to the river in 1993 were the cohorts of spawners in 1988 and the majority of returns in 1994 will be the cohorts of spawners in 1989. If the survival in the river and at sea of the 1989 cohort is no better than for the 1988 cohort then the return of small salmon to the Humber River in 1994 is anticipated to be lower than in 1993 (Fig. 10).

If the higher egg depositions in the Humber River/Bay of Islands region in 1992 and 1993, relative to previous years, are the result of the closure of the commercial fishery, there is reason to be optimistic about its effectiveness in rebuilding stocks. However, the full impact of the closure can only be fully evaluated by assessing the survival of the 1992 and 1993 cohorts. The first spawning adults produced after the commercial moratorium will not return to the Humber River until 1997.

In order to improve the accuracy of the mark recapture technique in assessing the the impact of the commercial closure on Humber River Atlantic salmon resource, estimates of recreational catches have to be improved. One way to accomplish this would be to conduct an intensive creel survey at Big Falls in 1994 in order to count all landings and ensure 100% reporting of all tags recaptured. Another improvement would be to obtain a complete count of small and large salmon returns to a portion of the river system either by using a counting fence or by installing a counting trap in the new Birchy Basin dam fishway.

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Table 1. Boundaries of Statistical Areas and Statistical Sections of Salmon Fishing Area (SFA) 13 and communities within coastal areas of Bay of Islands.

Statistical Area	Section	Boundary
K	40	Cape Ray to Sandy Point
	41	Sandy Point to Cape St. George
L	42	Cape St. George to Long Point
	43	Long Point to Bluff Head
	44	Bluff Head to Cape St. Gregory

Table 2. Standardized weeks used for summarizing catch and effort data.

Week	Time Period
22	May 28 to June 3
23	June 4 to 10
24	June 11 to 17
25	June 18 to 24
26	June 25 to July 1
27	July 2 to 8
28	July 9 to 15
29	July 16 to 22
30	July 23 to 29
31	July 30 to August 5
32	August 6 to 12
33	August 13 to 19
34	August 20 to 26
35	August 27 to Sept. 2
36	Sept. 3 to 9
37	Sept. 10 to 16
38	Sept. 17 to 23
39	Sept. 24 to 30
40	Oct. 1 to 7

Table 3. Equations used in estimation of Atlantic salmon returns to the Humber River, 1993. Parameters highlighted in bold type changed value with each iteration of the simulation procedure.

$$\text{RETURNS (Small)} = \frac{\text{CATCH (Small)}}{\text{EXPLOITATION RATE}}$$

$$\text{CATCH (Small)} = \frac{\textbf{Estimated Creel Catch at Big Falls}}{\textbf{Proportion of Catch from Big Falls}}$$

Proportion of Catch from Big Falls =

(Catch Method) $= \dfrac{\text{Catch at Big Falls (DFO statistics)}}{\text{Total River Catch (DFO statistics)}}$

$$= \frac{882}{2206} = 0.3998$$

(Tags Method) $= \dfrac{\text{Tag Returned from Big Falls}}{\text{Total Tags Returned}}$

$$= \frac{48}{119} = 0.4034$$

$$\text{EXPLOITATION RATE} = \frac{\text{Tags Recaptured}}{\text{Tags Available}}$$

$$\text{Tags Recaptured} = \frac{\text{Tags Returned}}{\textbf{Reporting Rate (RR)}}$$

Bootstrapping estimates from:
Tags Returned = 119
Varying Reporting Rate = 0.5 – 1.0; Mean = 0.75

Tags Available = Tags Applied X Proportion Tags Retained (PR)

PR = **1–(Tag Loss Rate) X Median Days to Recapture**

Range of Days to Recapture = 0 to 80 days; Median = 15
Tag Loss rate = 0.009 tags/day

(continued next page)

Table 3 (continued)

SUMMARY EQUATION:

$$\text{RETURNS (Small) (Catch Method)} = \text{Catch} \times \frac{\text{Tags Applied} \times \text{PR} \times \text{RR}}{\text{Tags Returned Voluntarily}}$$

$$\text{(Tags Method)} = \text{Catch} \times \frac{\text{Tags Applied} \times \text{PR} \times \text{RR}}{\text{Tags Returned Voluntarily}}$$

RETURNS (Large)
(Catch Method) = Returns Small X Proportion Large in Trapnets

(Tags Method) = Returns Small X Proportion Large in Trapnets

(Proportion Large = 32 / 910 = 0.035)

Solve RETURNS equations 5000 times to generate the distribution from which confidence limits can be determined.

Table 4. Recreational catch of small and large Atlantic salmon from the Bay of Islands region, 1953 to 1993. Numbers in parentheses and catches of large salmon, 1985–1993 are released fish.

	Small Salmon				Large Salmon			
		Bay of Islands, % of				Bay of Islands, % of		
Year	Bay of Islands	SFA 13	AREA L	Sec 44	Bay of Islands	SFA 13	Area L	Sec 44
1953	1260	28.0	90.7		149	11.5	64.8	
1954	876	34.1	88.1		137	15.8	69.9	
1955	1391	38.0	90.7		139	17.2	72.0	
1956	1103	23.9	77.7		114	7.9	40.3	
1957	1786	26.3	81.1		91	4.8	31.1	
1958	1687	33.1	87.9		195	9.9	47.6	
1959	1999	41.0	90.6		187	14.3	49.3	
1960	1943	31.9	90.0		179	19.3	55.2	
1961	1884	31.5	92.0		134	10.9	51.5	
1962	2411	25.6	82.0		110	7.5	32.7	
1963	3932	31.1	92.7		162	6.4	54.2	
1964	4832	33.7	89.6		273	10.8	42.0	
1965	4071	38.7	92.8		193	10.0	50.1	
1966	4118	51.0	93.0		322	17.1	74.4	
1967	2344	28.9	93.7		160	8.7	59.9	
1968	2477	29.6	90.1		96	8.4	59.3	
1969	4960	40.8	96.1		485	29.9	89.5	
1970	3445	35.4	96.1		553	33.7	93.1	
1971	4041	42.4	96.6		375	35.9	97.4	
1972	4065	48.4	97.2		221	20.0	95.3	
1973	3726	36.3	97.1	97.5	328	23.6	88.2	88.9
1974	2745	38.2	95.7	97.5	107	11.7	62.2	85.6
1975	6153	51.3	98.7	98.9	114	12.9	87.7	94.2
1976	5129	49.4	97.5	97.5	65	10.4	90.3	90.3
1977	2238	33.3	95.0	95.0	45	4.3	81.8	81.8
1978	2725	51.5	92.0	92.0	187	21.9	72.5	72.5
1979	3361	55.9	97.8	97.8	27	23.9	93.1	93.1
1980	3531	44.6	95.4	95.4	305	30.7	95.3	95.3
1981	4148	44.6	94.5	95.9	153	23.1	93.9	95.0
1982	4313	45.1	95.4	96.3	96	16.1	76.2	81.4
1983	3152	49.7	96.6	97.5	47	7.7	83.9	90.4
1984	2872	37.0	98.2	98.8	40	12.9	85.1	87.0
1985	2430	45.8	100.0	100.0	11	4.3	100.0	100.0
1986	3456	47.0	98.0	100.0	261	37.8	100.0	100.0
1987	3093	51.4	96.3	97.5	113	33.0	89.7	89.7
1988	4093	49.8	93.4	95.6	144	35.5	81.8	91.7
1989	1312	41.3	90.0	92.5	11	8.4	42.3	42.3
1990	3106	46.4	93.5	96.0	75	22.5	84.3	85.2
1991	1535	29.6	89.1	92.1	11	5.4	19.3	19.3
1992	2261 (214)	41.6	90.8	90.8	178	18.8	64.7	66.7
1993	2426 (603)	47.6	92.3	94.2	126	17.2	60.6	64.6
Mean								
1987–1991	2628	43.7	92.5	94.7	71	21.0	63.5	65.6
1953–1991	3019	39.5	92.9	96.5	164	16.6	70.7	83.4
% Change in 1993 from:								
1987–1991	−7.7	8.8	−0.2	−0.6	78.0	−17.9	−4.6	−1.6
1953–1991	−19.6	20.3	−0.6	−2.4	−23.4	3.9	−14.3	−22.5

Data Sources: 1953 to 1986, Mullins et al. (1989).
1987 to 1988, Mullins and Claytor (1989).
1989, Claytor and Mullins (1990).

Table 5. Recreational catch of small and large Atlantic salmon from Bay of Islands rivers, 1953 to 1993. Numbers in parentheses and catches of large salmon, 1985–1993 are released fish.

	Small Salmon					Large Salmon				
Year	Humber River	Hughes Brook	Cooks Brook	Goose Arm	Humber % of Bay of Islands	Humber River	Hughes Brook	Cooks Brook	Goose Arm	Humber % of Bay of Islands
1953	1260	0	0		100.0	149	0	0		100.0
1954	876	0	0		100.0	137	0	0		100.0
1955	1376	0	0	15	98.9	138	0	0	1	99.3
1956	1076	0	0	27	97.6	110	0	0	4	96.5
1957	1778	0	0	8	99.6	89	0	0	2	97.8
1958	1686	0	0	1	99.9	194	0	0	1	99.5
1959	1996	0	0	3	99.8	187	0	0	0	100.0
1960	1938	0	0	5	99.7	178	0	0	1	99.4
1961	1867	0	0	17	99.1	134	0	0	0	100.0
1962	2390	0	0	21	99.1	108	0	0	2	98.2
1963	3898	0	0	34	99.1	160	0	0	2	98.8
1964	4681	0	125	26	96.9	268	0	3	2	98.2
1965	3951	0	98	22	97.1	193	0	0	0	100.0
1966	3989	0	43	86	96.9	322	0	0	0	100.0
1967	2252	0	71	21	96.1	160	0	0	0	100.0
1968	2168	57	236	16	87.5	96	0	0	0	100.0
1969	4459	74	416	11	89.9	478	7	0	0	98.6
1970	2785	211	423	26	80.8	526	27	0	0	95.1
1971	3949	44	48	.	97.7	375	0	0	.	100.0
1972	3961	55	47	2	97.4	219	0	1	1	99.1
1973	3411	177	133	5	91.5	304	24	0	0	92.7
1974	2742	.	2	1	99.9	107	0	0	0	100.0
1975	6147	4	2	0	99.9	114	0	0	0	100.0
1976	5102	6	0	21	99.5	61	0	0	4	93.8
1977	2158	64	4	12	96.4	45	0	0	0	100.0
1978	2722	.	0	3	99.9	187	.	0	0	100.0
1979	3343	.	0	18	99.5	27	.	0	0	100.0
1980	3512	.	0	19	99.5	303	.	0	2	99.3
1981	4132	.	0	16	99.6	153	.	0	0	100.0
1982	4287	.	0	26	99.4	95	.	0	1	99.0
1983	3110	.	0	42	98.7	47	.	0	0	100.0
1984	2872	.	0	.	100.0	40	.	0	.	100.0
1985	2430	.	0	.	100.0	11	.	0	.	100.0
1986	3456	.	0	.	100.0	261	.	0	.	100.0
1987	3074	.	4	15	99.4	113	.	0	0	100.0
1988	4042	.	16	35	98.8	144	.	0	0	100.0
1989	1217	.	33	62	92.8	10	.	1	0	90.9
1990	3054	.	17	35	98.3	75	.	0	0	100.0
1991	1431	.	12	92	93.2	11	.	0	0	100.0
1992	2234 (194)	.	(3)	27 (17)	98.8	177	.	0	1	100.0
1993	2206 (601)	.	.	220 (2)	90.9	125	.	.	1	100.0
Mean										
1987–1991	2564		16	48	96.5	71	0	0	0	98.2
1953–1991	2938		44	20	97.4	162	1	0	1	98.9
% Change in 1993 from:										
1987–1991	−13.9		−100.0	360.3	−5.8	77.1	.	.	.	1.9
1953–1991	−24.9		−100.0	995.6	−6.7	−23.0	−100.0	.	60.9	1.1

Data Sources: 1953 to 1986, Mullins et al. (1989).
1987 to 1988, Mullins and Claytor (1989).
1989, Claytor and Mullins (1990)

Table 6. DFO catch statistics by standardized week for Atlantic salmon on the Humber River, 1993.

Week	Water Level	Effort (Rod–days)			Small Salmon							Large Salmon Released			Total Salmon Angled
					Retained			Released			Total Catch				
		Obs.	Est.	Total	Obs.	Est.	Total	Obs.	Est.	Total		Obs.	Obs.	Total	
23	High	59	8	67	.	.	.	.	.	.	.	.	.	.	.
24	High	79	20	99	.	.	.	.	.	.	.	.	3	3	3
25	High	206	70	276	44	10	54	12	11	23	77	10	4	14	91
26	High	189	173	362	69	44	113	22	14	36	149	8	12	20	169
27	High	437	398	835	169	207	376	79	99	178	554	.	11	11	565
28	Med.	401	728	1129	151	367	518	62	123	185	703	.	7	7	710
29	High	273	426	699	73	140	213	21	29	50	263	.	8	8	271
30	Med.	263	460	723	70	136	206	21	38	59	265	.	12	12	277
31	Med.	163	530	693	34	147	181	9	21	30	211	.	8	8	219
32	Med.	202	451	653	36	128	164	3	10	13	177	.	9	9	186
33	Low	133	385	518	24	98	122	3	13	16	138	.	11	11	149
34	Low	129	306	435	39	69	108	1	5	6	114	.	6	6	120
35	Med.	111	232	343	44	41	85	.	4	4	89	.	8	8	97
36	Med.	38	153	191	26	40	66	.	1	1	67	.	8	8	75
Total	Med.	2683	4340	7023	779	1427	2206	233	368	601	2807	18	107	125	2932

Table 7a. Recreational catch of small salmon retained from sections of the Humber River, 1976 to 1993. River sections are shown in Figures 1 and 2.

		Small salmon catch (number) by location on Humber River							
Year	Humber River Total	Lower Humber	Deer Lake	Harrim. Steady	Little Falls	Big Falls	Adies Stream	Adies Lake	Taylor's Brook
1976	5102	433	298	689	730	1891	343	718	.
1977	2158	229	82	118	359	1207	98	37	28
1978	2722	138	214	210	600	1071	171	198	120
1979	3343	641	275	415	317	1200	191	158	146
1980	3512	195	158	358	712	1817	171	63	38
1981	4132	250	260	327	368	2226	375	242	84
1982	4287	107	53	390	677	2767	154	98	41
1983	3110	218	571	401	409	726	177	446	162
1984	2872	170	101	532	633	1069	210	3	154
1985	2430	38	319	69	382	989	210	423	.
1986	3456	238	239	144	496	1367	189	783	.
1987	3074	218	209	673	313	1234	50	355	22
1988	4042	225	57	502	929	1563	228	369	169
1989	1214	31	189	187	181	316	195	57	58
1990	3054	148	44	763	372	1138	107	434	48
1991	1431	138	179	364	83	504	95	7	61
1992	2234	61	126	354	166	1497	1	26	3
1993	2206	120	62	469	426	882	130	14	103
Mean									
1987–1991	2563	152	136	498	376	951	135	244	72
1977–1986	3202	222	227	296	495	1444	195	245	77
% Change in 1993 from:									
1987–1991	−13.9	−21.1	−54.3	−5.8	13.4	−7.3	−3.7	−94.3	43.9
1977–1986	−31.1	−46.0	−72.7	58.2	−14.0	−38.9	−33.2	−94.3	33.2

Table 7b. Recreational catch (number) of large salmon from sections of the Humber River, 1976 to 1993. River sections are shown in Figures 1 and 2.

		Large salmon catch (number) by location on Humber River							
Year	Humber River Total	Lower Humber	Deer Lake	Harrim. Steady	Little Falls	Big Falls	Adies Stream	Adies Lake	Taylor's Brook
1976	61	18	0	10	5	14	4	10	.
1977	45	10	1	0	6	26	2	0	0
1978	187	6	19	2	32	111	16	1	0
1979	27	10	0	4	0	13	0	0	0
1980	303	19	4	4	99	157	10	10	0
1981	153	61	2	1	6	78	4	1	0
1982	95	32	1	3	4	53	2	0	0
1983	47	13	1	1	4	24	1	2	1
1984	40	2	0	6	5	27	0	0	0
1985	0	0	0	0	0	0	0	0	.
1986	0	0	0	0	0	0	0	0	.
1987	0	0	0	0	0	0	0	0	0
1988	144	4	0	0	30	86	16	0	8
1989	8	1	0	0	0	7	0	0	0
1990	75	54	0	0	7	14	0	0	0
1991	11	11	0	0	0	0	0	0	0
1992	177	22	0	17	14	113	7	3	17
1993	125	48	0	0	15	42	12	2	6
Mean									
1987–1991	48	14	0	0	7	21	3	0	2
1977–1986	90	15	3	2	16	49	4	1	0
% Change in 1993 from:									
1987–1991	162.6	242.9	.	.	102.7	96.3	275.0	.	275.0
1977–1986	39.4	213.7	−100.0	−100.0	−3.8	−14.1	242.9	42.9	5900.0

Table 7c. Recreational effort (rod–days) on sections of the Humber River, 1976 to 1993. River sections are shown in Figures 1 and 2.

		Effort (rod–days) by location on Humber River							
Year	Humber River Total	Lower Humber	Deer Lake	Harrim. Steady	Little Falls	Big Falls	Adies Stream	Adies Lake	Taylor's Brook
1976	10489	1415	430	1454	1620	4076	369	1125	.
1977	6127	1243	494	288	778	2445	316	407	156
1978	7633	1312	883	503	1036	2390	491	598	420
1979	7961	1540	737	1010	891	2696	441	274	372
1980	8292	941	879	761	1365	3310	515	338	183
1981	8701	1355	701	708	914	3718	602	447	256
1982	8737	1240	206	816	1476	4194	318	370	117
1983	7746	1762	1224	803	945	1746	387	539	340
1984	7189	1359	322	1281	1174	2412	377	6	258
1985	7211	1196	570	282	1079	2807	479	798	.
1986	8635	1814	586	465	1082	2634	484	1570	.
1987	7250	1764	482	1005	804	2377	129	641	48
1988	8521	1247	144	923	1769	2894	512	630	402
1989	6014	749	434	713	783	1543	1200	220	372
1990	7008	805	193	1319	980	2377	300	843	191
1991	5770	1038	465	922	357	2014	411	63	500
1992	6072	1237	414	1034	360	2698	115	114	100
1993	7023	976	249	1210	936	2657	501	104	390
Mean									
1987–1991	6913	1121	344	976	939	2241	510	479	303
1977–1986	7823	1376	660	692	1074	2835	441	535	210
% Change in 1993 from:									
1987–1991	1.6	−12.9	−27.5	23.9	−0.3	18.6	−1.8	−78.3	28.9
1977–1986	−10.2	−29.1	−62.3	74.9	−12.8	−6.3	13.6	−80.5	85.5

Table 8a. Estimate of catch of small salmon retained by week at Big Falls, Humber River, obtained by DFO catch statistics method and Creel method.

Dates	Week	DFO statistics Estimate	DFO statistics % of Total	Creel % of Total	Creel Estimate	Creel Variance	Creel Std.Dev.	Creel Lower C.I.	Creel Upper C.I.	Creel Coef. Var.
Small Salmon Catch Estimate (Kept)										
June 8–June 14	1	0	0.0	0.0	0	0	0.0	0.0	0.0	.
June 15–June 21	2	10	0.7	0.2	4	12	3.5	−2.9	10.9	86.6%
June 22–June 28	3	64	4.3	8.4	140	632	25.1	89.7	190.3	18.0%
June 29–July 5	4	106	7.1	7.7	129	28	5.3	118.4	139.6	4.1%
July 6–July 12	5	263	17.6	28.2	473	6199	78.7	315.5	630.5	16.6%
July 13–July 19	6	129	8.6	24.1	404	667	25.8	352.3	455.7	6.4%
July 20–July 26	7	118	7.9	10.2	171	282	16.8	137.4	204.6	9.8%
July 27–Aug. 2	8	66	4.4	13.6	228	1543	39.3	149.4	306.6	17.2%
Aug. 3–Aug. 9	9	62	4.1	3.0	50	923	30.4	−10.8	110.8	60.8%
Aug. 10–Aug. 16	10	31	2.1	3.9	65	302	17.4	30.2	99.8	26.7%
Aug. 17–Aug. 23	11	17	1.1	0.7	12	22	4.7	2.6	21.4	39.1%
Aug. 24–Aug. 30	12	8	.	.	.	.	.	.	.	.
Aug.31–Sept. 7	13	8	.	.	.	.	.	.	.	.
	14	.	.	.	.	.	.	.	.	.
	15	.	.	.	.	.	.	.	.	.
	Total	882			1676	10610	103.0	1470.0	1882.0	6.1%

Table 8b. Estimate of catch of small salmon retained and released by week at Big Falls, Humber River, obtaine by DFO catch statistics method and Creel method.

Dates	Week	DFO statistics Estimate	DFO statistics % of Total	Creel % of Total	Creel Estimate	Creel Variance	Creel Std.Dev.	Creel Lower C.I.	Creel Upper C.I.	Creel Coef. Var.
Small Salmon Catch Estimate (Released)										
June 8–June 14	1	0	0.0	0.0	0	0	0.0	0.0	0.0	.
June 15–June 21	2	1	0.1	0.0	0	0	0.0	0.0	0.0	.
June 22–June 28	3	20	1.3	0.4	6	8	2.8	0.3	11.7	47.1%
June 29–July 5	4	11	0.7	0.2	3	4	2.0	−1.0	7.0	66.7%
July 6–July 12	5	103	6.7	1.7	28	82	9.1	9.9	46.1	32.3%
July 13–July 19	6	17	1.1	1.3	22	45	6.7	8.6	35.4	30.5%
July 20–July 26	7	36	2.3	0.2	3	3	1.7	−0.5	6.5	57.7%
July 27–Aug. 2	8	3	0.2	2.1	36	79	8.9	18.2	53.8	24.7%
Aug. 3–Aug. 9	9	3	0.2	0.0	0	0	0.0	0.0	0.0	.
Aug. 10–Aug. 16	10	1	0.1	0.0	0	0	0.0	0.0	0.0	.
Aug. 17–Aug. 23*	11	1	0.1	0.9	15	105	10.2	−5.5	35.5	68.3%
Aug. 24–Aug. 30	12	.	.	.	.	.	.	.	.	.
Aug.31–Sept. 7	13	.	.	.	.	.	.	.	.	.
	14	.	.	.	.	.	.	.	.	.
	15	.	.	.	.	.	.	.	.	.
	Total	196			113	326	18.1	76.9	149.1	16.0%

* Creel survey completed Aug. 20.

Table 8c. Estimate of catch of large salmon released by week at Big Falls, Humber River, obtained by DFO catch statistics method and Creel method.

Dates	Week	DFO statistics Estimate	DFO statistics % of Total	Creel % of Total	Creel Estimate	Creel Variance	Creel Std.Dev.	Creel Lower C.I.	Creel Upper C.I.	Creel Coef. Var.
Large Salmon Catch Estimate (Released)										
June 8–June 14	1	0	0.0	0.0	0	0	0.0	0.0	0.0	.
June 15–June 21	2	2	1.8	0.0	0	0	0.0	0.0	0.0	.
June 22–June 28	3	20	17.7	17.9	19	38	6.2	6.7	31.3	32.4%
June 29–July 5	4	5	4.4	0.0	0	0	0.0	0.0	0.0	.
July 6–July 12	5	3	2.7	0.0	0	0	0.0	0.0	0.0	.
July 13–July 19	6	2	1.8	17.9	19	102	10.1	−1.2	39.2	53.2%
July 20–July 26	7	7	6.2	2.8	3	3	1.7	−0.5	6.5	57.7%
July 27–Aug. 2	8	3	2.7	28.3	30	111	10.5	8.9	51.1	35.1%
Aug. 3–Aug. 9	9	0	0.0	0.0	0	0	0.0	0.0	0.0	.
Aug. 10–Aug. 16	10	0	0.0	33.0	35	218	14.8	5.5	64.5	42.2%
Aug. 17–Aug. 23*	11	0	0.0	0.0	0	0	0.0	0.0	0.0	.
Aug. 24–Aug. 30	12	.	.	.	.	.	.	.	.	.
Aug.31–Sept. 7	13	.	.	.	.	.	.	.	.	.
	14	.	.	.	.	.	.	.	.	.
	15	.	.	.	.	.	.	.	.	.
	Total	42			106	472	21.7	62.5	149.5	20.5%

Table 8d. Estimate of recreational effort by week at Big Falls, Humber River, obtained by DFO catch statistics method and Creel method.

Dates	Week	DFO statistics Estimate	DFO statistics % of Total	Creel % of Total	Creel Estimate	Creel Variance	Creel Std.Dev.	Creel Lower C.I.	Creel Upper C.I.	Creel Coef. Var.
Effort Estimate (rod–days for DFO statistics; hours for Creel)										
June 8–June 14	1	30	1.1	0.1	96	7196	84.8	−73.7	265.7	88.4%
June 15–June 21	2	119	4.5	4.2	3141	1658739	1287.9	565.2	5716.8	41.0%
June 22–June 28	3	166	6.2	9.3	7025	400321	632.7	5759.6	8290.4	9.0%
June 29–July 5	4	325	12.2	11.3	8537	720822	849.0	6839.0	10235.0	9.9%
July 6–July 12	5	562	21.1	24.9	18848	4328012	2080.4	14687.2	23008.8	11.0%
July 13–July 19	6	339	12.7	20.0	15093	1976742	1406.0	12281.1	17904.9	9.3%
July 20–July 26	7	368	13.8	12.6	9547	367434	606.2	8334.7	10759.3	6.3%
July 27–Aug. 2	8	265	9.9	9.1	6860	738450	859.3	5141.3	8578.7	12.5%
Aug. 3–Aug. 9	9	251	9.4	4.3	3265	173689	416.8	2431.5	4098.5	12.8%
Aug. 10–Aug. 16	10	87	3.3	2.4	1840	120050	346.5	1147.0	2533.0	18.8%
Aug. 17–Aug. 23*	11	59	2.2	1.8	1358	161229	401.5	554.9	2161.1	29.6%
Aug. 24–Aug. 30	12	44	.	.	.	.	.	.	.	.
Aug.31–Sept. 7	13	24	.	.	.	.	.	.	.	.
	14	.	.	.	.	.	.	.	.	.
	15	.	.	.	.	.	.	.	.	.
	Total	2639			75610	10652684	3263.8	69082.3	82137.7	4.3%

* Creel survey completed Aug. 20.

Table 9. Summary of Big Falls creel survey observations, 1993.

Week	Number Anglers Interviewed	Total Effort (hours)	Mean Effort per Angler (hours)	Number Small		Number Large Salmon Released	Number Carlin Tags Observed
				Kept	Released		
2	41	133.7	3.26	1	.	.	0
3	91	281.7	3.10	5	1	1	0
4	197	714.7	3.63	51	2	6	0
5	263	907.6	3.45	76	1	.	0
6	384	1585.0	4.13	125	15	1	0
7	229	812.3	3.55	59	3	4	2
8	198	838.2	4.23	52	2	3	0
9	111	411.2	3.70	33	5	2	0
10	44	172.0	3.91	4	.	1	0
11	38	130.3	3.43	5	.	2	0
12	17	44.5	2.62	1	1	.	0
Total	1613	6030.5	3.74	412	30	20	2
1992 Values*	607	2628.1	4.33	738	59	25	5
1991 Values	726	1600.0	2.20	136			

* Only anglers with catch interviewed in 1992.

Table 10. Comparison by half month period of the proportion of anglers with catch interviewed by the creel survey clerk at Big Falls, Humber River in 1991 and 1993.

1993 Analysis

	Number Anglers Interviewed				Proportion of Anglers with Catch			
	June	July−1	July−2	Aug−1	June	July−1	July−2	Aug−1
Small Kept								
0	321	475	303	101				
1	71	226	105	11	0.18	0.32	0.26	0.10
Total	392	701	408	112				

1991 Analysis

	Number Anglers Interviewed				Proportion of Anglers with Catch			
	June	July−1	July−2	Aug−1	June	July−1	July−2	Aug−1
Small Kept								
0	133	203	148	127				
1	6	52	31	5	0.04	0.19	0.17	0.04
2	1	14	5	1	0.01	0.05	0.03	0.01
Total	140	269	184	133	0.05	0.25	0.20	0.05

Table 10. Comparison by half month period of the proportion of anglers with catch interviewed by the creel survey clerk at Big Falls, Humber River in 1991 and 1993.

1993 Analysis

	Number Anglers Interviewed				Proportion of Anglers with Catch			
	June	July−1	July−2	Aug−1	June	July−1	July−2	Aug−1
Small Kept								
0	321	475	303	101				
1	71	226	105	11	0.18	0.32	0.26	0.10
Total	392	701	408	112				

1991 Analysis

	Number Anglers Interviewed				Proportion of Anglers with Catch			
	June	July−1	July−2	Aug−1	June	July−1	July−2	Aug−1
Small Kept								
0	133	203	148	127				
1	6	52	31	5	0.04	0.19	0.17	0.04
2	1	14	5	1	0.01	0.05	0.03	0.01
Total	140	269	184	133	0.05	0.25	0.20	0.05

Table 11. Weekly distribution of tagged and recaptured salmon on the Humber River, 1993. The exploitation rate (ER) is based on the total number of fish tagged excluding those recaptured at Hughes Brook. ER is unadjusted for tag loss or reporting rate.

Standardized Week	Number Brights Tagged	Cumulative Number Tagged	Recaptures		Unadjusted ER
			From Anglers	From Hughes	
Small Salmon					
23	0	0	0	.	.
24	33	33	0	1	0.0000
25	155	188	2	2	0.0108
26	135	323	7	2	0.0283
27	185	508	21	2	0.0599
28	260	768	23	4	0.0700
29	22	790	19	.	0.0924
30	26	816	13	.	0.1056
31	4	820	12	.	0.1199
32	3	823	7	.	0.1281
33	3	826	4	1	0.1327
34	2	828	6	.	0.1397
35	2	830	1	.	0.1406
36	0	830	4	.	0.1455
Total	830	830	119	12	0.1455
Large salmon					
23	0	0	.	.	.
24	7	7	.	.	0.000
25	15	22	1	.	0.045
26	2	24	.	.	0.042
27	0	24	.	.	0.042
28	3	27	.	.	0.037
29	0	27	.	.	0.037
30	0	27	.	.	0.037
31	0	27	.	.	0.037
32	0	27	.	.	0.037
33	1	28	.	.	0.036
34	0	28	.	.	0.036
35	0	28	.	.	0.036
Total	28	28	1	0	0.036

Table 11. Number of small salmon tagged in the lower and upper trapnets on the Humber River in 1993 (excluding those recaptured at Hughes Brook) and number returned by anglers.

	Number Grilse Tagged			Number Tags Returned			Number
Week	Lower Trapnet	Upper Trapnet	Total	Lower Trapnet	Upper Trapnet	Total	Grilse Angled
24	26	7	32	8	2	0	0
25	93	62	153	18	11	2	54
26	66	69	133	11	7	7	113
27	142	43	183	17	6	21	376
28	228	32	256	29	3	23	518
29	13	9	22	0	2	19	213
30	16	10	26	4	1	13	206
31	4	0	4	0	0	12	181
32	3	0	3	0	0	7	164
33	3	0	2	0	0	4	122
34	2	0	2	0	0	6	108
35	2	0	2	0	0	1	85
36	0	0	0	0	0	4	66
Total	598	232	818	87	32	119	2206

Table 12. Number of Atlantic salmon tagged on the Humber River, 1993 by water temperature class and the number recaptured by angling, the counting fence on Hughes Brook and in the tagging trapnets.

Water Temperature Class (C)	Mean Water Temperature	No. Tagged	No. Recaptured	Proportion Recaptured	No. Recaptured by: Angling	Fence	Trap
0.0–4.9	.	0	0	.	0	0	0
5.0–9.9	8.4	264	49	0.19	44	0	5
10.0–14.9	11.0	548	84	0.15	69	10	5
15.0–19.9	15.6	10	3	0.30	0	2	1
20.0–up	.	0	0	.	0	0	0
Total	10.3	822	136	0.17	113	12	11

Table 13. Distribution of tagged small and large salmon recaptured on the Humber River, 1993 by major angling area and recapture week.

Week Tagged	Week of Recapture by Location: Hughes Brook Counting Fence						Trapnet Recaptures						Lower Humber					Deer Lake	Harrimans Steady										Little Falls							
	29	32	33	34	35	37	24	25	26	28	31	33	26	28	29	30	31	30	25 Small	27 Small	28 Small	29 Small	30 Small	31 Small	32 Small	34 Small	36 Small	25 Large	25	26	27	28	29	30	31	32
24	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.
25	.	.	.	.	.	.	.	2	.	.	.	.	2	.	.	.	.	.	1	3	.	.	1	.	.	.	.	.	.	1	4	1	.	.	.	.
26	.	.	.	.	1	.	.	.	1	1	.	.	.	.	.	.	.	.	.	2	3	.	.	1	1	.	.	.	.	.	.	.	1	1	.	1
27	1	.	.	.	1	.	.	.	.	.	.	.	.	1	.	1	.	.	.	1	3	2	1	2	.	1	.	.	.	.	.	2	.	.	1	.
28	1	.	1	1	.	.	.	.	.	3	1	.	.	.	1	1	1	1	.	.	1	9	3	1	.	.	.	.	.	.	.	1	1	.	1	.
29	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
30	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.
31	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
32	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
33	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	2	1	1	3	4	1	1	2	1	4	1	1	3	1	1	2	1	1	1	6	7	11	5	4	1	2	1	1	1	1	4	4	2	1	3	1

NOTE: Two of the recaptures at Big Falls were observed by DFO creel survey clerk.

(continued)

Big Falls										Adies Stream	Adies Lake	Taylors Brook			Total Tags Ret.	Total tags Returned from Angling	
26	27	28	29	30	31	32	33	34	36	27	32	34	35	36		Small	Large
1	5	1	.	.	.	.	.	.	.	.	.	.	.	1	12	11	1
2	3	3	2	1	2	1	.	.	1	.	.	.	1	.	31	29	.
.	.	7	.	.	.	.	.	.	.	1	.	.	.	.	21	18	.
.	2	.	1	1	1	.	1	1	.	.	.	.	.	1	25	23	.
.	.	.	2	2	1	2	3	.	.	.	1	.	.	.	39	32	.
.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	5	2	.
.	.	.	.	.	.	1	.	1	.	.	.	1	.	.	5	5	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
3	10	11	5	4	4	4	4	2	1	1	1	2	1	2	142	119	1

Table 14. Estimation by two week period of angling exploitation rate (ER) based on tags available adjusted for tag loss rate and tag recaptures adjusted for reporting rate.

Release Period	No. Small Tagged* (X1)	Median Days to Recapture (X2)	Proportion of Tags Retained (1−(X2*0.009)=X3)	Adjusted Tags Available (X1*X3=X4)	Tags Returned (X5)	Assumed Reporting Rate (X6)	Adjusted Tags Recaptured (X5/X6=X7)	Adjusted Angling ER (X7/X4=X8)
24−25	188	17	0.847	159	39	0.75	52	0.3266
26−27	317	13	0.883	280	41	0.75	55	0.1953
28−29	276	11	0.901	249	34	0.75	45	0.1823
30−35	37	25	0.775	29	5	0.75	7	0.2325
Overall	818	15	0.865	716	119	0.75	159	0.2214

* Number tagged is adjusted for recaptures at the Hughes Brook counting fence

Table 15. Biological characteristics of Humber River Atlantic salmon, 1993.

	Smolt Age Group	Fork Length (cm) N	Mean	Min	Max	Std	Whole Weight (kg) N	Mean	Min	Max	Std	Percentage Female No. Sexed	N	%	Smolt Age N	%	Mean
DFO Trapnets																	
Small (<63 cm)																	
1SW	2	28	51.9	47.2	58.3	2.59	2	1.20	1.1	1.3	0.14	2	2	100.0	28	3.1	.
	3	747	53.2	38.3	61.6	2.85	46	1.43	0.8	2.6	0.36	49	33	67.4	751	84.2	.
	4	110	54.4	49.5	61.4	2.56	6	1.57	1.1	2.2	0.38	7	4	57.1	112	12.7	.
	Total	885	53.3	38.3	61.6	2.84	54	1.44	0.8	2.6	0.36	58	39	67.2	891	100.0	3.09
MSW	3	1	61.7	61.7	61.7	.	0	.	.	.	.	0	.	.	1	100.0	.
	Total	1	61.7	61.7	61.7	.	0	.	.	.	.	0	.	.	1	100.0	3.00
Large (>=63 cm)																	
1SW	4	1	63.9	63.9	63.9	.	0	.	.	.	.	0	.	.	1	100.0	.
	Total	1	63.9	63.9	63.9	.	0	.	.	.	.	0	.	.	1	100.0	4.00
MSW	2	4	68.8	63.2	74.6	5.36	0	.	.	.	.	0	.	.	4	14.3	.
	3	22	72.2	63.4	77.8	3.51	1	5.00	5.0	5.0	.	1	1	100.0	22	78.6	.
	4	2	71.4	69.7	73.1	2.40	0	.	.	.	.	0	.	.	2	7.1	.
	Total	28	71.7	63.2	77.8	3.79	1	5.00	5.0	5.0	.	1	1	100.0	28	100.0	2.93
1SW AS (171)	3	2	84.1	79.8	88.3	6.01	0	.	.	.	.	0	.	.	2	100.0	.
	Total	2	84.1	79.8	88.3	6.01	0	.	.	.	.	0	.	.	2	100.0	3.00
Angled Salmon																	
Small (<63 cm)																	
1SW	3	65	55.2	49.5	62.0	2.50	50	1.65	1.0	2.7	0.31	59	40	67.8	65	75.6	.
	4	21	56.7	49.5	62.5	3.53	19	1.78	1.3	2.4	0.31	21	13	61.9	21	24.4	.
	Total	86	55.6	49.5	62.5	2.84	69	1.69	1.0	2.7	0.31	80	53	66.3	86	100.0	3.20
1SW CS	3	1	63.0	63.0	63.0	.	1	2.40	2.4	2.4	.	1	1	100.0	1	100.0	.
	Total	1	63.0	63.0	63.0	.	1	2.40	2.4	2.4	.	1	1	100.0	1	100.0	3.00

Table 16. Estimation of Atlantic salmon spawner requirements for the Humber River, 1993.

HUMBER RIVER

Rearing Units (100 sq. m)		115,307	(Porter and Chadwick, 1983)
Lacustrine Area (ha)		1,751	(this document)
Optimum Egg Deposition		240 eggs per Rearing Unit	(Elson, 1957)
		368 eggs per hectacre of Lacustrin	(O'Connell et al., 1991)
Biological Characteristics:			
Fecundity		1,540 eggs / kg	
Small – (<63 cm)	% overall	91.1	(trapnet, 1992–93)
	% female	60.3	(recreational, 1992–93)
	mean wt	1.825 kg	(recreational, 1992–93)
Large – (>=63 cm)	% overall	8.85	(trapnet, 1992–93)
	% female	68.6	(commercial, 1991)
	mean wt	3.7 + kg	(Porter and Chadwick, 1983)

Spawners for Sufficient Females:

Spawners Required (Minimum) = egg requirements / eggs per spawner

$$= \frac{(115{,}307 * 240) + (1751 * 368)}{(\%\text{Small} * \%\text{female} * \text{mean wt.} * \text{fecundity}) + (\%\text{large} * \%\text{female} * \text{mean wt.} * \text{fecundity})}$$

$$= \frac{28{,}318{,}048}{(0.911 * 0.603 * 1.825 * 1{,}540) + (0.0885 * 0.686 * 3.7 * 1540)}$$

$$= \frac{28{,}318{,}048}{1{,}890}$$

$$= 14{,}984$$

	total	females	males
Small	13,651	8,231	5,419
Large	1,326	910	416
Totals	14,977	9,141	5,836

Spawners for Sufficient Males:

Deficit Males – Small	=	8,231	–	5,419	=	2,812
Deficit Males – Large	=	910	–	416	=	493
Small spawners for deficit males	=	2,812	/	39.7%		
	=	7,083				
Large spawners for deficit males	=	493	/	31.4%		
	=	1,571				

Total spawner requirements for 1:1 spawning ratio:

Small =	20,734
Large =	2,897
Total	23,631

Note: Spawner requirements are updated from previous reports to reflect egg deposition requirements for both fluvial and lacustrine habitat.

Table 17. Summary of parameters used to estimate spawning escapement of Atlantic salmon to the Humber River, 1993.

Parameter			Median	Percentiles 5%	95%
Tags Recaptured*			159	122	228
Tags Available**			708	674	738
Exploitation Rate			0.2246	0.1810	0.3089
Estimated Total Angling Catch: Total Catch of Small salmon = (Creel Catch / Proportion Angled at Big Falls)					
	Catch Method (Proportion=0.3998)		4,195	3,736	4,667
	Tags method (Proportion=0.4034)		4,161	3,401	5,193
Estimated Returns (Peterson – single census):					
Based on:	Catch Method	Small	18,656	12,866	25,027
		Large	642	397	980
		Total	19,298	13,263	26,007
	Tags Method	Small	18,477	12,194	26,585
		Large	636	379	1,024
		Total	19,113	12,573	27,609
Estimated Spawning Escapement:					
Based on:	Catch Method	Small	14,461	9,130	20,360
		Large	642	397	980
		Total	15,103	9,527	21,340
	Tags Method	Small	14,316	8,793	21,392
		Large	636	379	1,024
		Total	14,952	9,172	22,416

* Adjusted for mean reporting rate of 0.75.
** Adjusted for tag loss based on 0.009 tags/day.

Table 18. Estimation of Atlantic salmon egg deposition and percentage conservation requirement achieved in the Humber River, 1993. All parameter values are from Porter and Chadwick (1983) except where noted.

HUMBER RIVER

Rearing Units (100 sq. m)		115,307	
Lacustrine Area (ha)		1,751 (this document)	
Optimum Egg Deposition		240 eggs per Rearing Unit 368 eggs per hectacre of Lacustrine Area	
Biological Characteristics, 1993:			
Fecundity		1,540 eggs / kg	
Small – (<63 cm)	% overall	96.5	(trapnet, 1993)
	% female	66.3 (n=80)	(recreational, 1993)
	mean wt	1.69 kg (n=69)	(recreational, 1993)
Large – (>=63 cm)	% overall	3.5	(trapnet, 1993)
	% female	68.6	(commercial, 1991)
	mean wt	3.7 + kg	

Percent Target Eggs Achieved:

= potential egg depositions / minimum conservation requirement X 100

$$= \frac{\text{small spawners} * (\text{eggs per small spawner}) + \text{large spawners} * (\text{eggs per large spawner})}{(\text{Rearing Units} * 240 \text{ eggs / unit}) + (\text{Lacustrine Area} * 368 \text{ eggs / ha})} \text{ X } 100$$

Where:

Eggs per Small Spawner = (.663 * 1.69 * 1,540)
= 1,726

Eggs per Large Spawner = (.686 * 3.7 * 1,540)
= 3,909

$$= \frac{(\text{small spawners} * 1726) + (\text{large spawners} * 3909)}{28{,}318{,}048} \text{ X } 100$$

Spawning Escapement Based on:

		Median	Percentiles 5%	95%
Catch Method	Small	14,461	9,130	20,360
	Large	642	397	980
	Total	15,103	9,527	21,340
Tags Method	Small	14,316	8,793	21,392
	Large	636	379	1,024
	Total	14,952	9,172	22,416

Percent Target Eggs Achieved:

Catch Method	97%	61%	138%
Tags Method	96%	59%	144%

Table 19. Summary of Atlantic salmon spawning escapement and percent of conservation requirements met on the Humber River, 1974–1993.

STOCK: Humber River, SFA 13

MINIMUM REQUIREMENT FOR CONSERVATION*: 28.3 million eggs (~ 13,651 Small and 1,326 Large salmon)
(Minimum Spawner Requirements)

Year	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Total Angling Catch:																				
Small	2742	6147	5102	2158	2722	3343	3512	4132	4287	3110	2872	2430	3456	3074	4042	1217	3054	1431	4349	4161
Large	107	114	61	45	187	27	303	153	95	47	40	11	261	113	144	10	75	11	177	112
Estimated Total Returns:**																				
Small	10968	24588	20408	8632	10888	13372	14048	16528	17148	12440	11488	9720	13824	12296	16168	4868	12216	5724	17571	18477
Large	768	1721	1429	604	762	936	983	1157	1200	871	804	680	968	861	1132	341	855	401	2945	636
Total	11736	26309	21837	9236	11650	14308	15031	17685	18348	13311	12292	10400	14792	13157	17300	5209	13071	6125	20516	19113
Estimated Spawning Escapement:																				
Small	8226	18441	15306	6474	8166	10029	10536	12396	12861	9330	8616	7290	10368	9222	12126	3651	9162	4293	13222	14316
Large	661	1607	1368	559	575	909	680	1004	1105	824	764	680	968	861	1132	341	855	401	2945	636
Total	8887	20048	16674	7033	8741	10938	11216	13400	13966	10154	9380	7970	11336	10083	13258	3992	10017	4694	16167	14952
% of Minimum Conservation Requirement Met (Small + Large)*:**																				
	52	119	100	42	50	66	64	79	83	61	56	48	68	61	80	24	60	27	117	96

* The minimum egg deposition requirement has been adjusted from previous reports to reflect total available rearing habitat including the available lacustrine area.

** Total returns for 1974–1991 were estimated based on an angling exploitation rate of 25% adjusted for tag loss and reporting rate (Chaput and Mullins, 1990)

*** 1974–1990 is based on biological characteristics from Porter and Chadwick, 1983.

Table 20. Counts of Atlantic salmon and date on which 50% of cumulative catches at the Hughes Brook and North Brook counting fences, 1984–1993.

Year	Hughes Brook Fence				North Brook Fence			
	Small <63cm	Large >63cm	Total	Date to 50%	Small <63cm	Large >63cm	Total	Date to 50%
1984	90	3	93	Aug. 11	.	.	.	
1985	13	0	13	Sept. 8	.	.	.	
1986	63	2	65	N/A	66	3	69	Aug. 10
1987	37	6	43	Sept. 28	74	1	75	Sept. 9
1988	65	0	65	Aug. 5	166	9	175	Aug. 29
1989	54	1	55	N/A	46	2	48	N/A
1990	106	1	107	Aug. 2	49	0	49	Aug. 4
1991	175	0	175	Aug. 6	52	1	53	Aug. 7
1992	146	7	153	Aug. 1	131	12	143	Aug. 22
1993	(87)	(0)	(87)	Aug. 11	(39)	(1)	(40)	Sept. 4

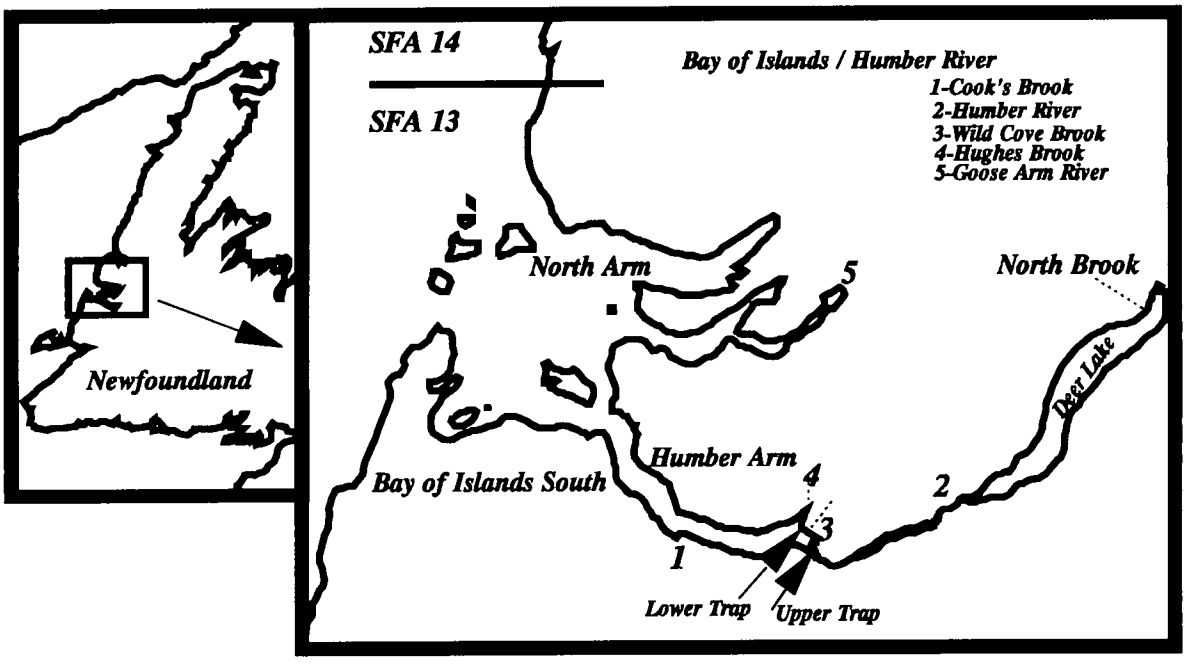

Figure 1. Location of rivers flowing into Bay of Islands, Newfoundland.

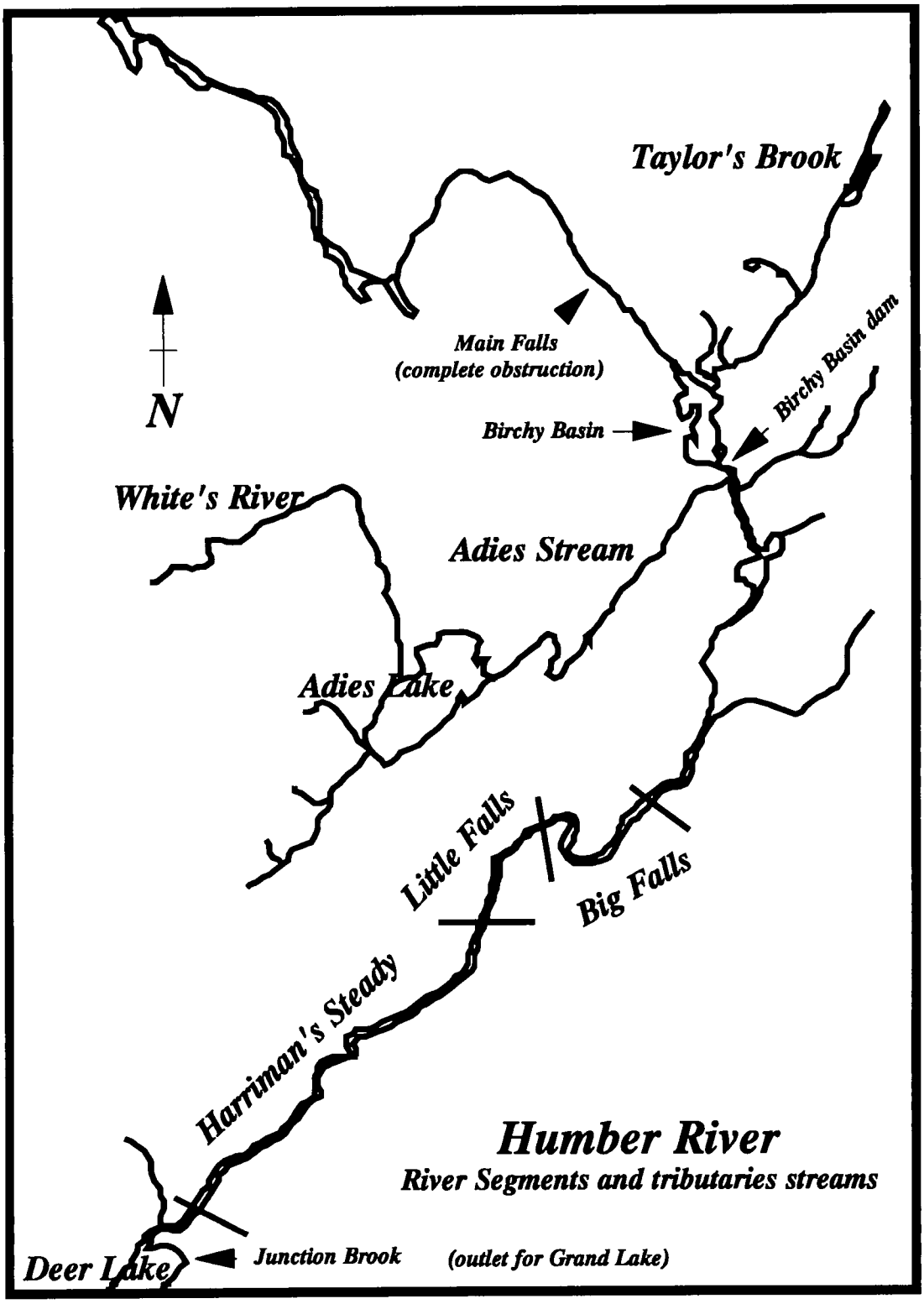

Figure 2. River segments of the Humber River, upstream of Deer Lake.

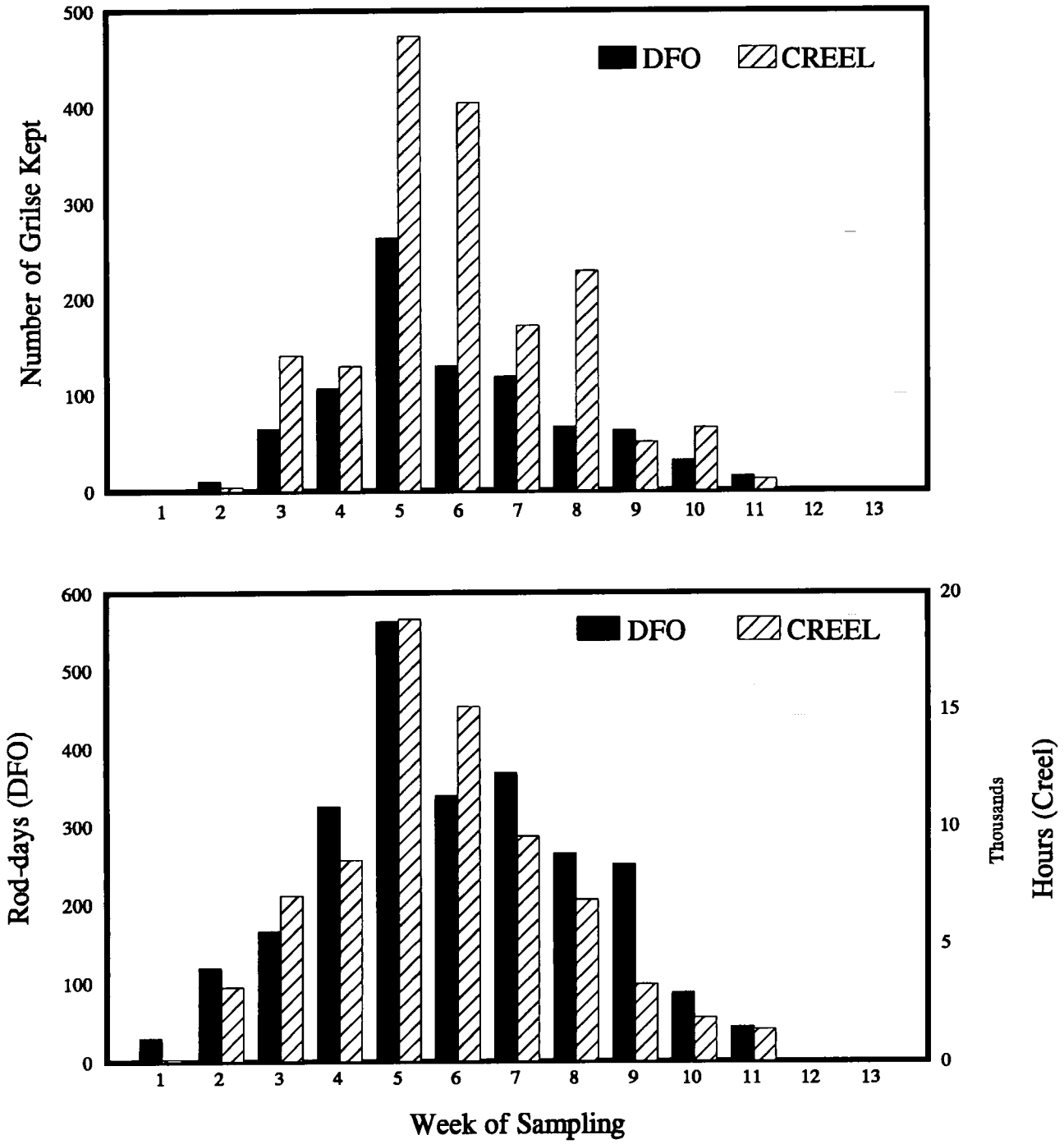

Figure 3. Comparison of catch and effort obtained by DFO guardian and creel survey methods at Big Falls, 1993.

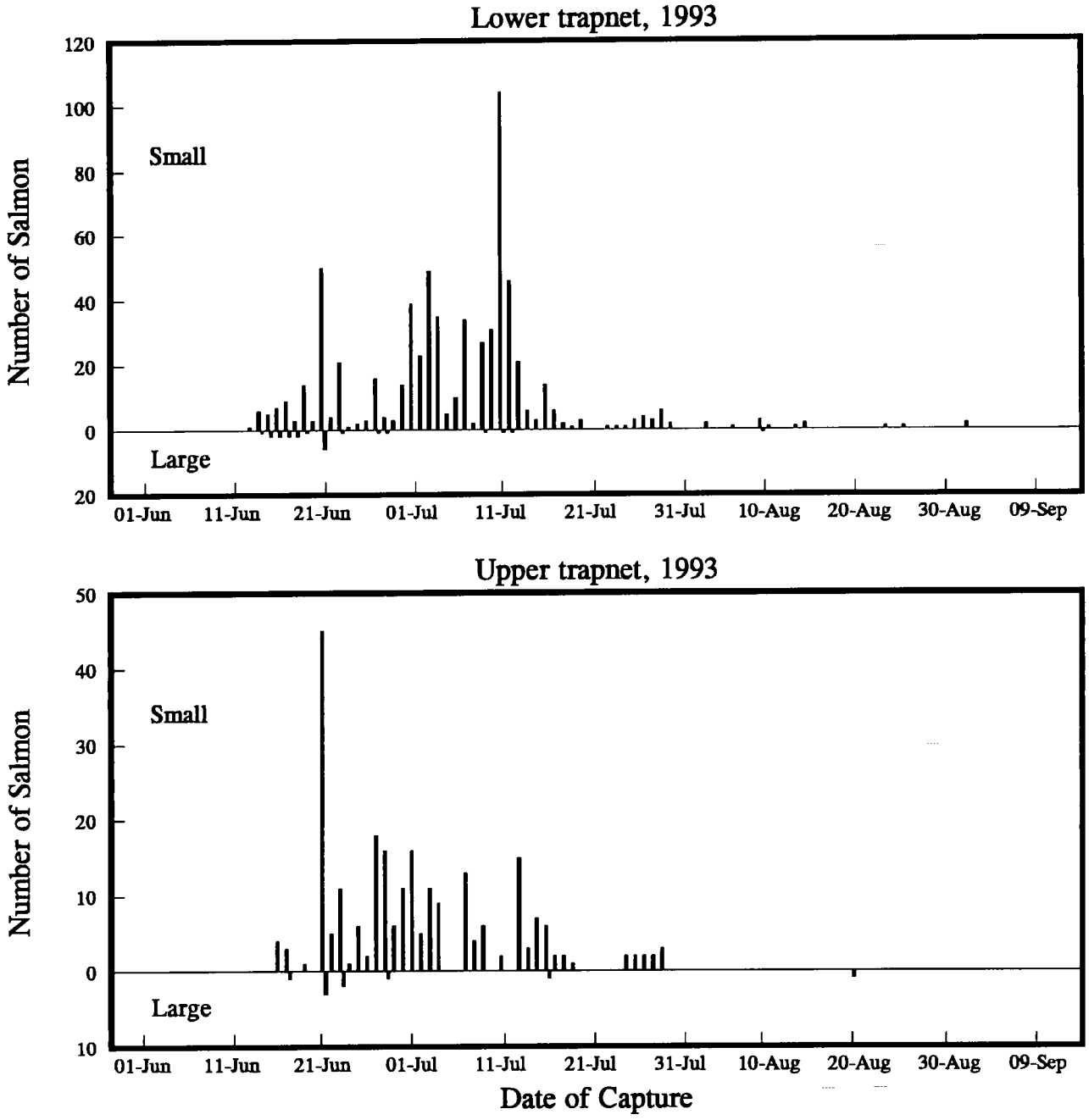

Figure 4. Distribution of returning small and large salmon catches at two trapnet locations in 1993.

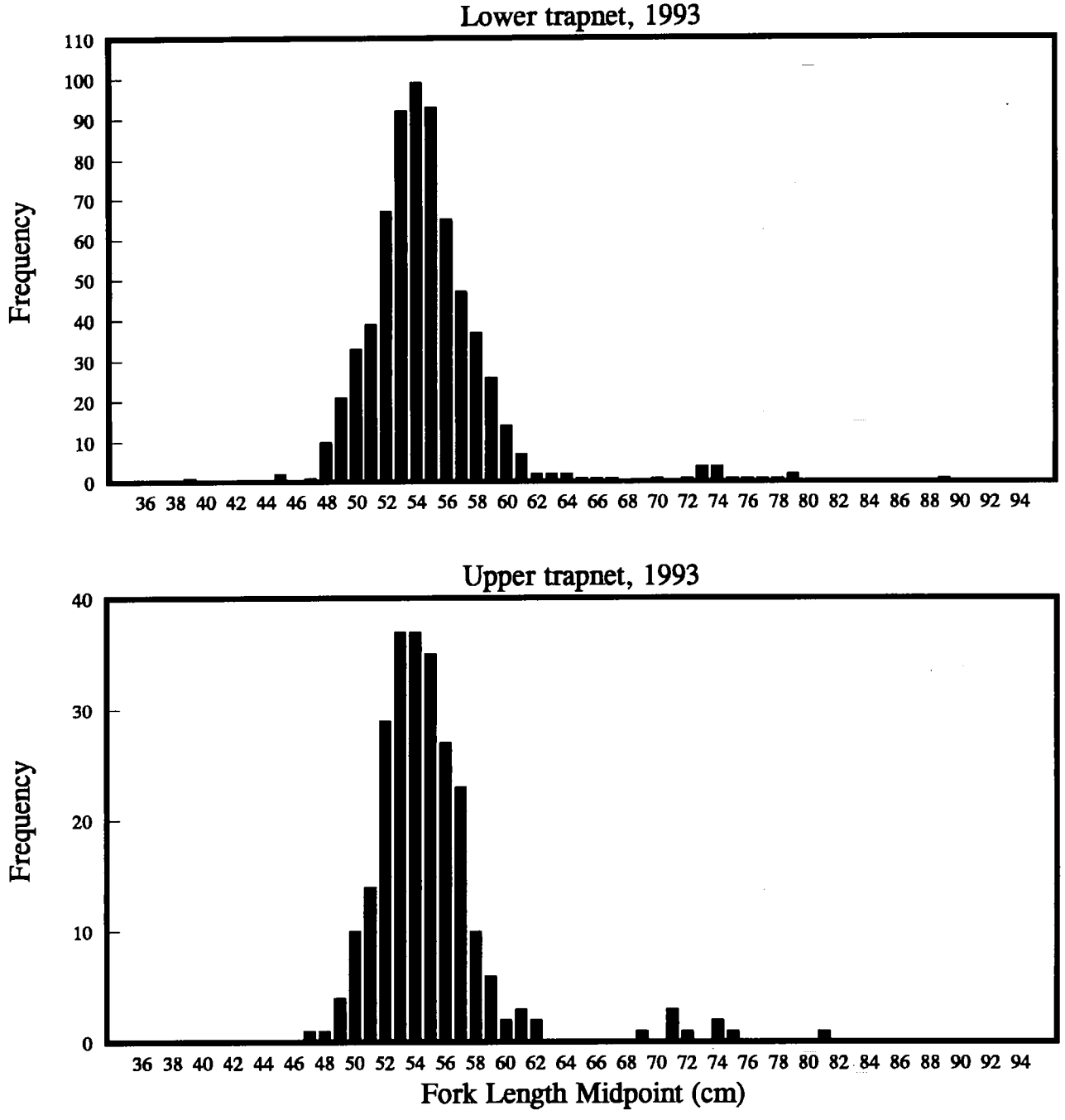

Figure 5. Fork Length frequency distribution of Atlantic salmon captured at the two trapnet locations in 1993.

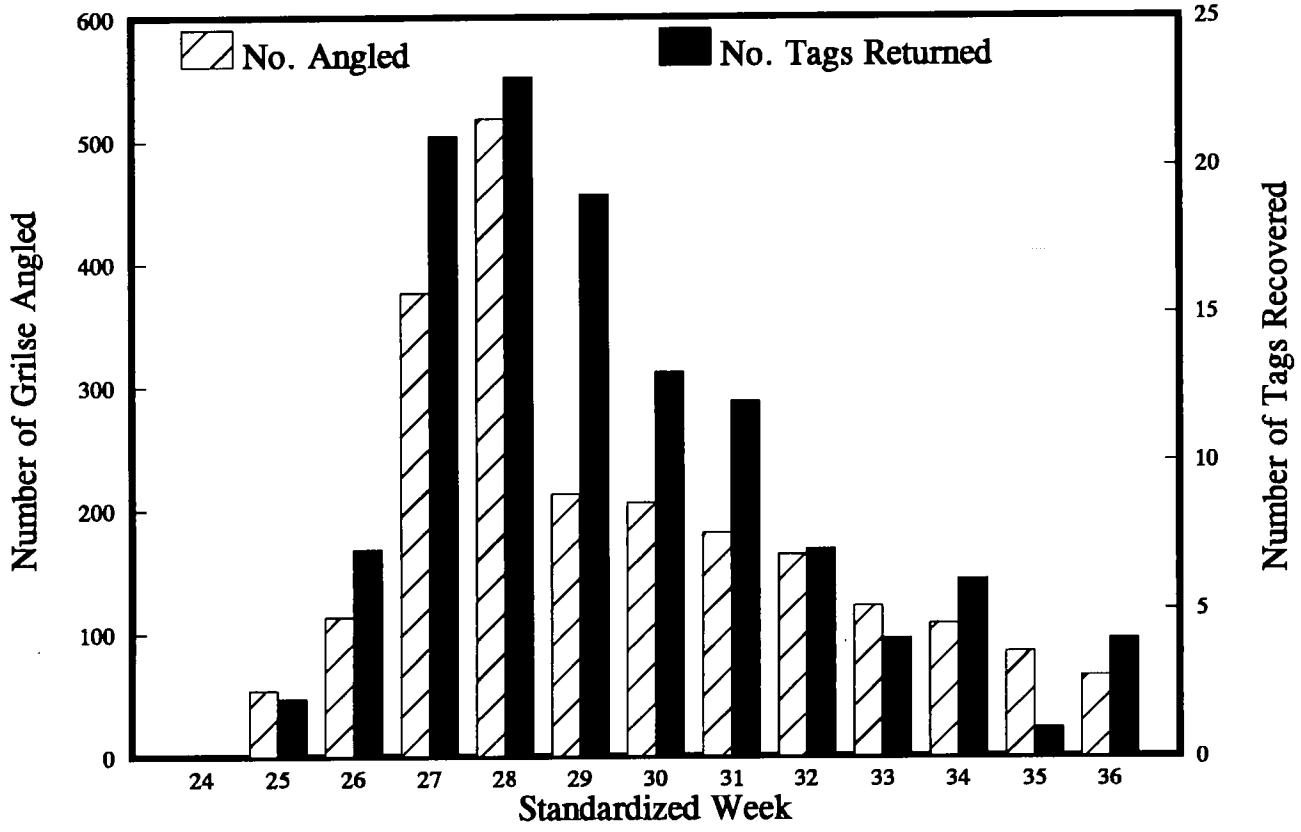

Figure 6. Timing of angling catches and recaptures of carlin tagged Atlantic salmon on the Humber River, 1993.

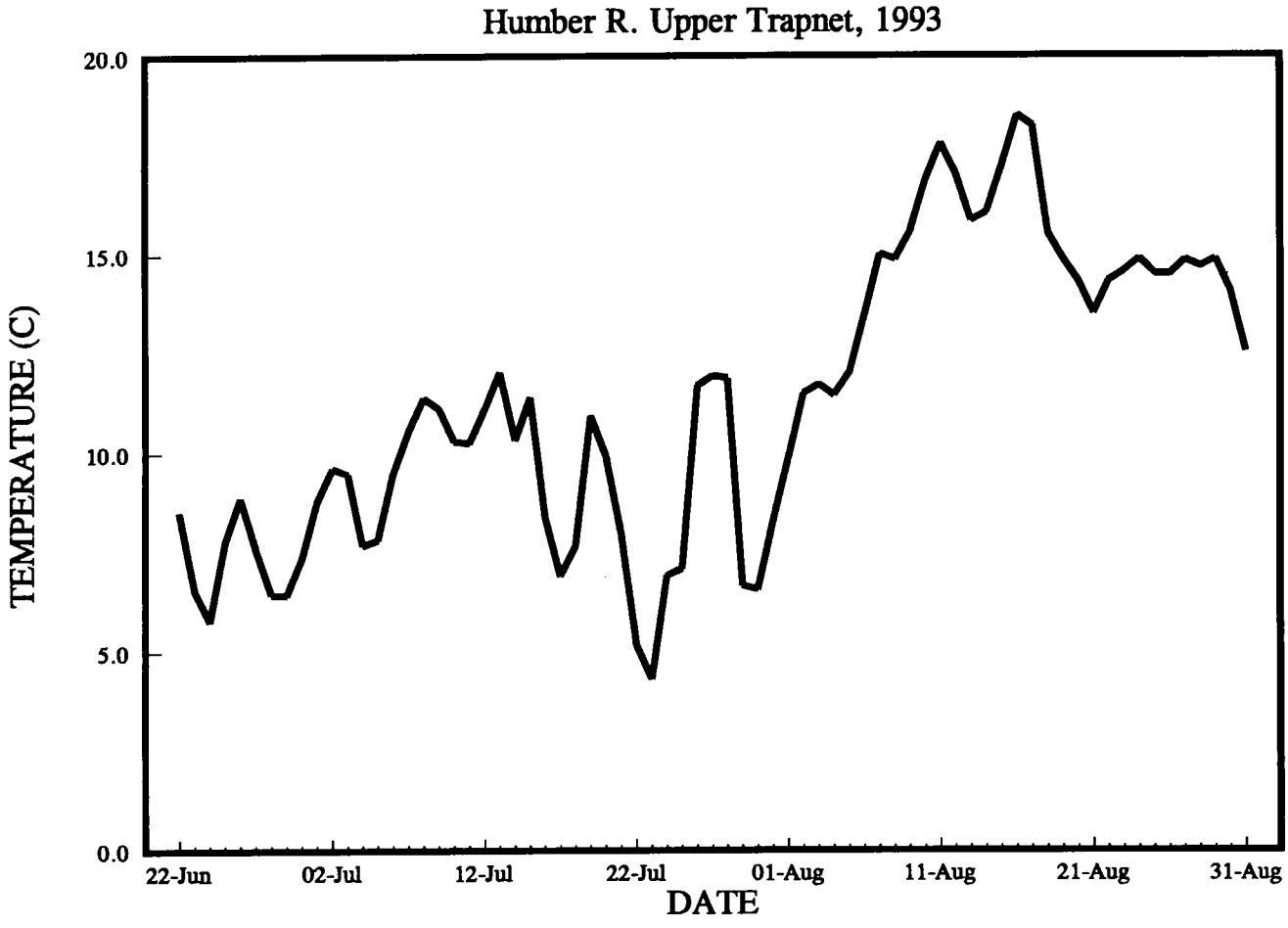

Figure 7. Mean daily water temperature at the upper tagging trap on the Humber River in 1993. Temperature is recorded approximately two metres off the bottom.

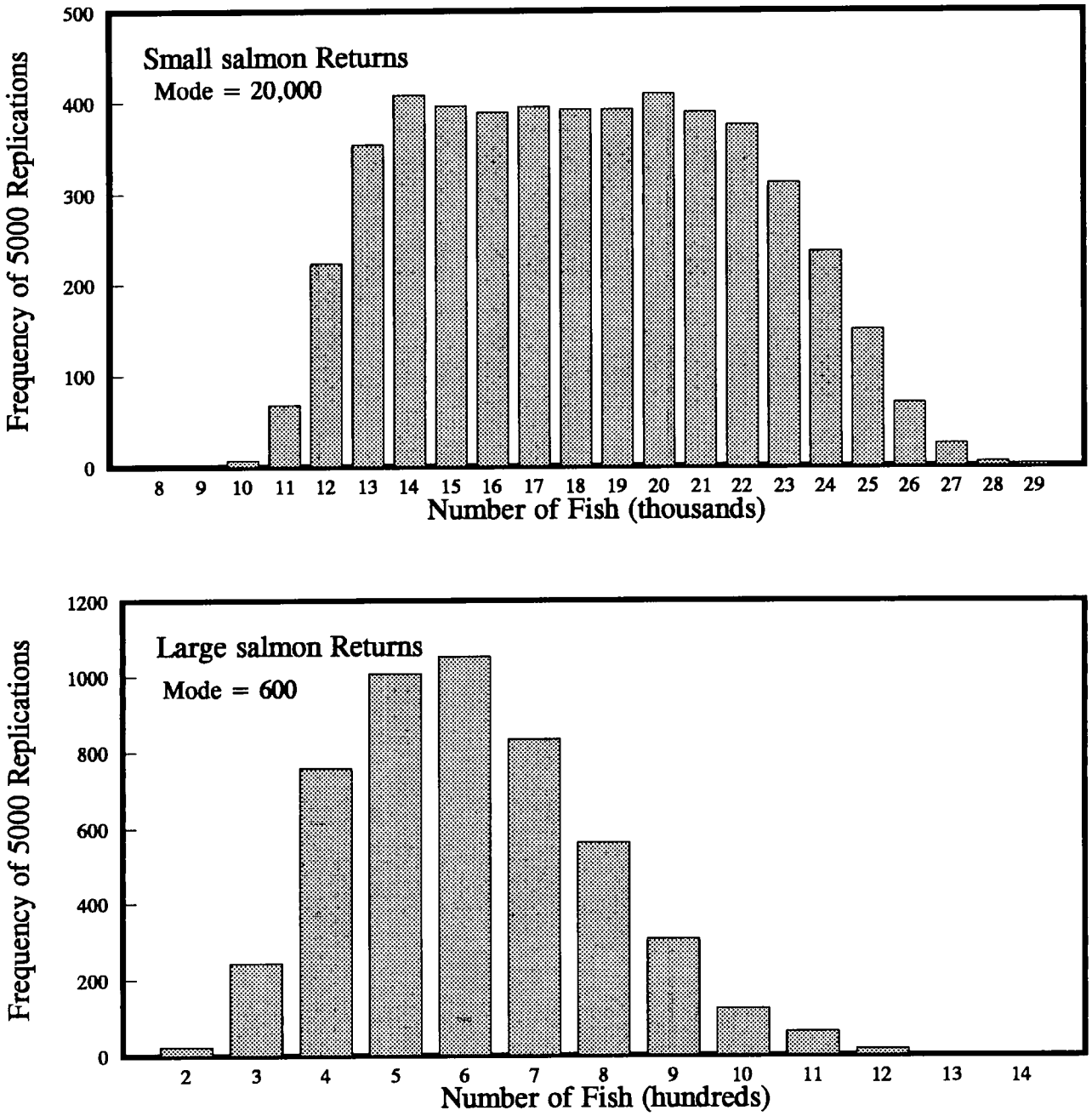

Figure 8. Frequency distribution of estimated small and large salmon returns to the Humber River, 1993 based on angling catch estimated from the proportion of catch landed at Big Falls and derived exploitation rates.

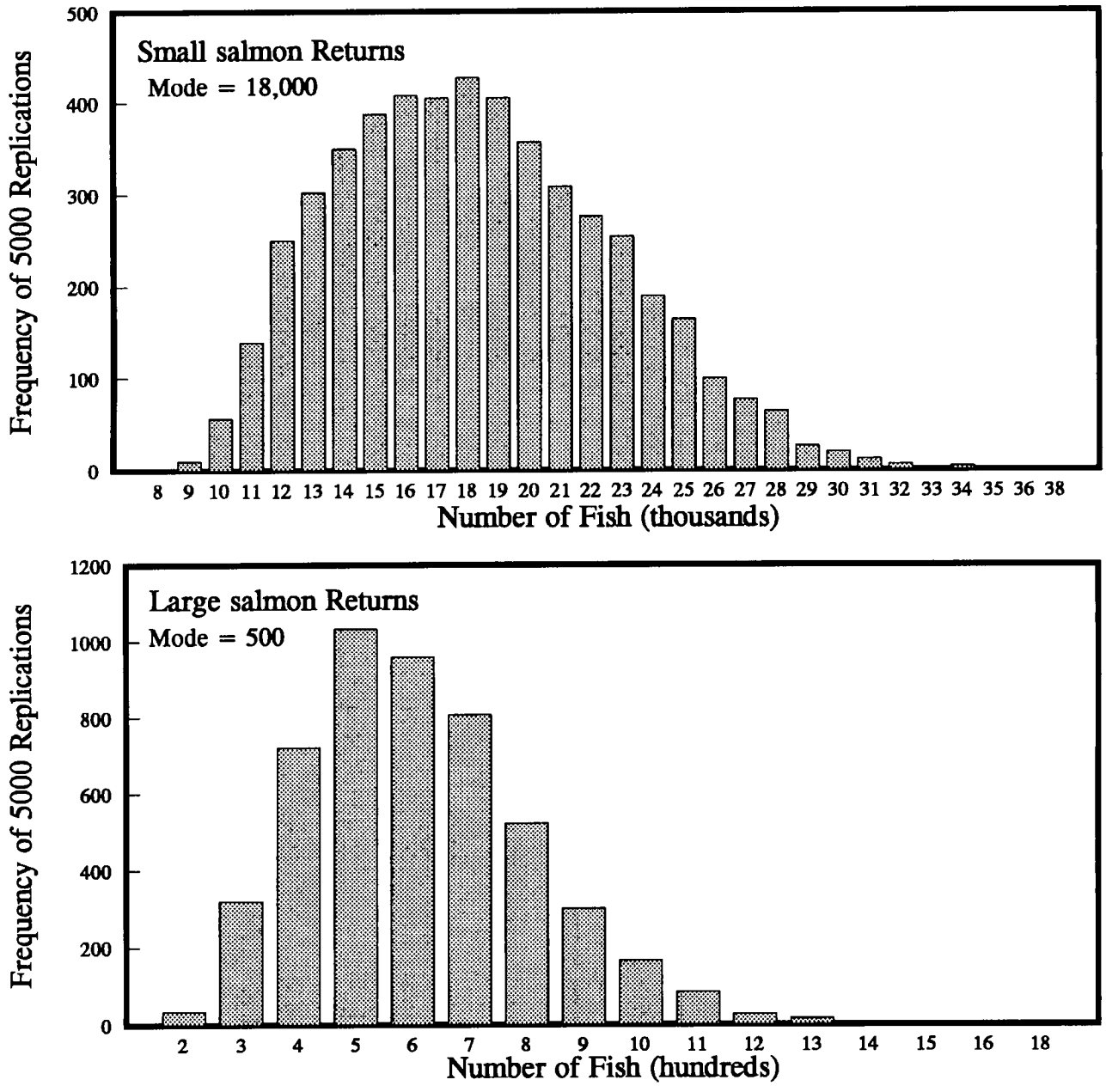

Figure 9. Frequency distribution of estimated small and large salmon returns to the Humber River, 1993 based on angling catch estimated from the proportion of tags returned from Big Falls and derived exploitation rates.

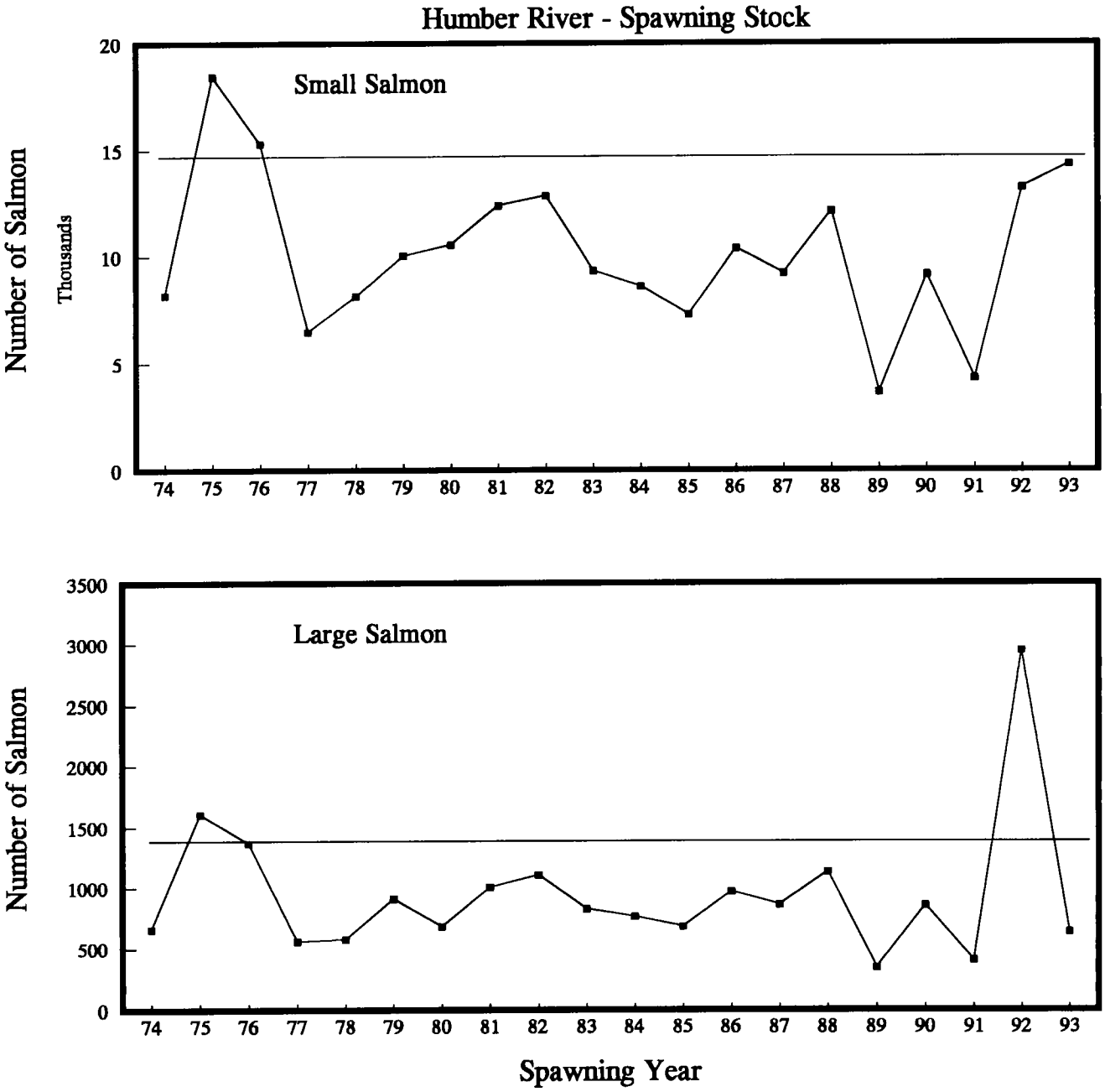

Figure 10. Spawning stock of small and large salmon on the Humber River, 1974-1993. Horizontal lines represent the target spawner requirements.

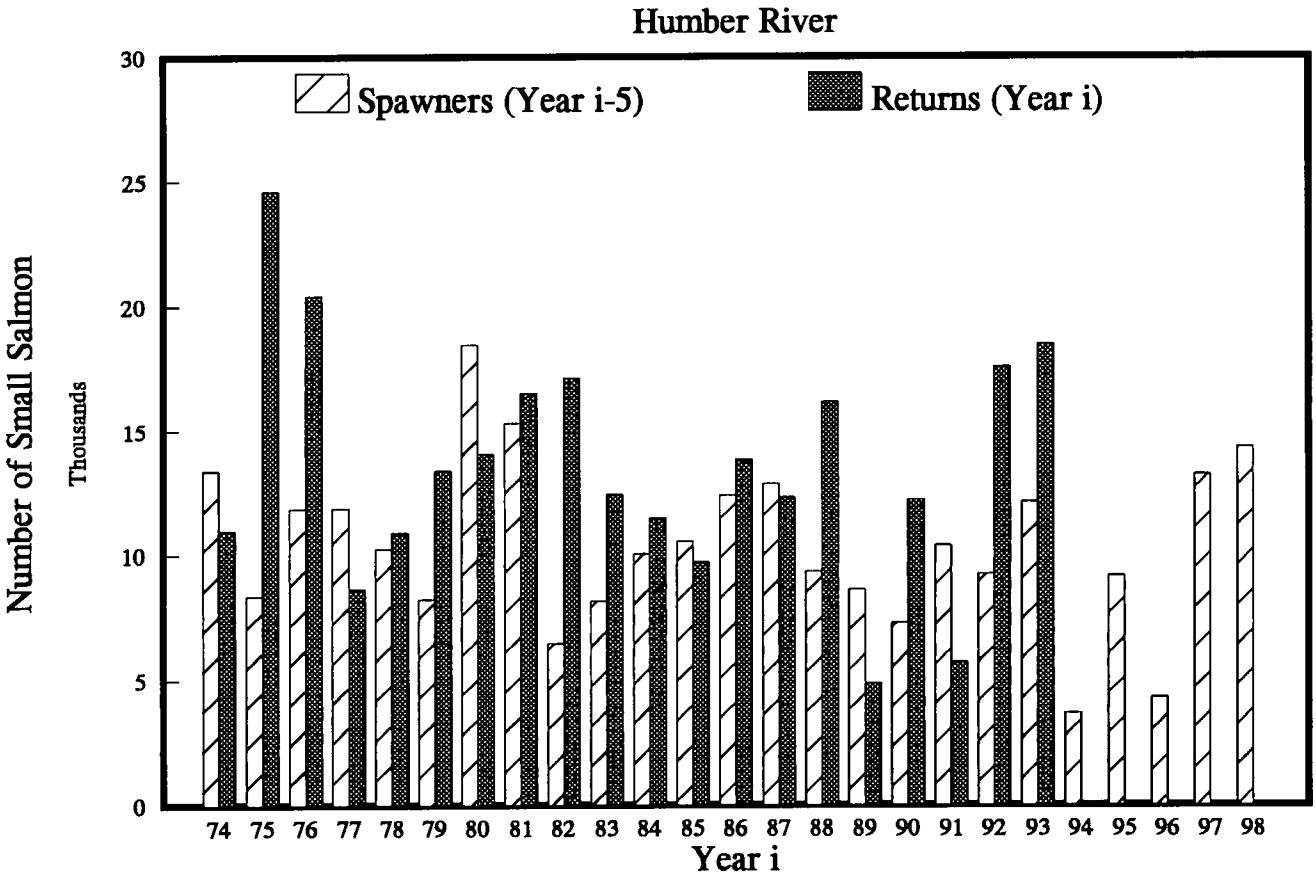

Figure 11. Small Atlantic salmon spawners and returns to the Humber River, 1974-1993.

APPENDIX 1. Instructions for conducting the creel survey at Big Falls, Humber River, 1991.

The creel survey at Big Falls is designed similar to a bus route. The clerk travels to one location, waits a fixed interval of time, then moves on to next site and waits required interval of time at second site, etc. For Big Falls, only two sites have been designated therefore the route is very simple.

The two designated stops on the route are the stairs at the boat landing spot (designated as boat) and the stairs immediately upstream of the boat landing (designated as stair). The standard waiting period at the boat location is 4 hours (240 minutes) while the stair stop period is 1 hour (60 minutes).

The day is divided into four time periods as follows:

A - 05:30 to 10:00
B - 10:00 to 14:00
C - 14:00 to 18:00
D - 18:00 to 22:30

At each pool, the clerk will interview as many anglers departing as possible. Critical data include nuumber of grilse kept, number of grilse released, number of large salmon released. Any grilse which are kept by the angler should be examined for the following critical features:

1 - presence of external Carlin tag (blue) - record number, angler name and ask angler to return tag to the address indicated on the tag.
2 - if no tag is present on fish, examine for tagging scar, two holes immediately below the dorsal fin.
3 - if no long line up of anglers, collect fork length and scales (if present) from fish
4 - ask angler time started fishing for that day.

It is more important to look at all fish being brought out, get accurate count of fish being caught and presence of tags or tagging scars. Length, scales and effort information are secondary.

The starting point of the creel and the time which the clerk spends at the very first stop may vary from day to day and period to period. The starting point and the duration of the initial stop are given on the schedule. The clerk is expected to work the duration of each time period and this may involve moving between the two interview locations several times.

For example, looking at the schedule, we see that for June 13, a creel is to be conducted during the 10:00 to 14:00 PM period. Looking at the schedule, the starting point is location 'boat' at time 10:00. The clerk should be ready to start intercepting anglers at that time at the boat landing site. Note also that the clerk would spend 30 minutes there (from 10:00 to 10:30) at which time, the person would move to the other location, stair. The clerk will stay at stair for 1 hour (10:45 to 11:45 assuming that the travel time from the boat landing spot to the bottom of the stair is 15 minutes) and intercept departing anglers. At 11:45, the clerk leaves and moves to the boat landing again. Assuming that the walk takes 15 minutes, then the clerk would intercept anglers at the boat landing between 12:00 and 14:00 at which time the sampling for that time period is over.

APPENDIX 1 (cont'd). Big Falls, Humber River creel survey design after selection of dates, time periods and starting locations.

A = 530 - 1000
B = 1000 - 1400
C = 1400 - 1800
D = 1800 - 2030

Loc. - boat = boat landing path
stair = up river stairs
Time - = time clerk should be at river to start interviews
Dur. = duration (minutes) clerk spends at the first site before moving on to next site
Normally duration of creel is 4 hours (240 minutes) at boat location and 1 hour (60 minutes) at stair location. Travel between locations is estimated at 15 minutes one-way.

			A	B	C	D			Creel A			Creel B			Creel C			Creel D		
			4.5	4	4	4.5	TOTAL HOURS		Loc.	Time	Dur.	Loc.	Time	Dur.	Loc.	Time	Dur.	Loc.	Time	Dur.
Sat.	June	8	1	0	1	0	8.5		boat	530	225				boat	1400	105			
		9	0	0	1	1	8.5								boat	1400	30	boat	1800	60
Mon.		10	0	0	0	0	0													
		11	1	1	0	0	8.5		boat	530	165	stair	1015	60						
		12	0	0	0	0	0													
		13	0	1	1	0	8					boat	1000	30	stair	1400	60			
Fri.		14	0	1	0	1	8.5	42				boat	1000	75				stair	1815	60
Sat.		15	0	0	1	1	8.5								boat	1400	150	boat	1800	90
		16	0	0	0	0	0													
Mon.		17	0	1	0	1	8.5					boat	1000	240				stair	1800	60
		18	1	0	0	1	9		boat	530	120							boat	1800	195
		19	1	0	1	0	8.5		boat	530	15				stair	1415	60			
		20	0	1	1	0	8					boat	1015	240	boat	1400	180			
Fri.		21	0	0	0	0	0	42.5												
Sat.		22	0	0	1	1	8.5								boat	1415	240	stair	1800	30
		23	1	1	0	0	8.5		stair	530	15	stair	1000	60						
Mon.		24	1	0	0	1	9		stair	530	45							boat	1800	45
		25	0	0	0	0	0													
		26	0	1	0	1	8.5					boat	1000	90				boat	1800	225
		27	0	0	0	0	0													
Fri.		28	1	0	1	0	8.5	43	boat	530	75				boat	1400	45			
Sat.		29	1	0	0	1	9		boat	530	45							boat	1800	45
		30	0	1	0	1	8.5					boat	1000	45				boat	1800	225
Mon.	July	1	1	0	1	0	8.5		boat	530	210				boat	1400	120			
		2	0	0	1	1	8.5								stair	1400	60	boat	1800	180
		3	1	1	0	0	8.5		boat	530	195	boat	1000	180						
		4	0	1	1	0	8					boat	1000	210	stair	1415	60			
Fri.		5	1	1	0	0	8.5	59.5	boat	530	180	stair	1000	45						

Appendix 2. Lacustrine area (ha) measured in the Humber River watershed area.

Stream/Lake Name or Location	Area (ha)
Humber River	2.4
Links Pond	4.8
Strattons Pond	4.0
Tippings Pond	16.8
The Old Man	3.2
The Old Man	5.6
Ducans Brook	0.8
Dogwood	3.2
Steady Brook	2.4
Steady Brook	2.4
Steady Brook	5.6
Steady Brook	0.8
Steady Brook	0.8
Steady Brook	4.8
Steady Brook	2.4
E. Steady Bk.	2.4
E. Steady Bk.	2.4
E. Steady Bk.	6.4
E. Steady Bk.	17.6
E. Steady Bk.	3.2
E. Steady Bk.	2.4
Bairds Pond	1.6
Angle Pond	4.8
Island Pond	15.2
Wildcove Lake	20.0
Rubber Lake	70.4
Rubber Lake	13.6
Matthews Brook	28.2
Matthews Brook	15.2
Big Tenth Pond	14.4
Blue Gulch Pond	92.8
West Pond	8.8
Hobo Pond	8.0
Little North Pond	84.8
Deer Lake	5930.4
Small Pond	12.0
Coal Brook	11.2
Adies Lake	656.0

Jones Pond	10.4
Harrimans Brook	24.8
Small Pond	21.6
Small Pond	10.4
Eastern Branch	35.2
Adies River	20.8
Adies River	9.6
Adies River	9.6
Otter Pond	21.6
Birchy Hill Brook	33.6
Birchy Hill Brook	15.2
Alder Pond	73.6
Alder Brook	10.4
Birchy Lake	144.0
E. Adies River	20.0
E. Adies River	22.4
NE. Adies River	15.2
Balls Pond	20.0
Whites River	22.4
Whites River	12.8
Whites River	18.4
Whites River	12.0
Beaver Brook	15.2
TOTAL	7681.0